ASSESSING THE SUSTAINABILITY OF THE HARVESTING OF ORANGE-HEADED THRUST CHICKS ON BALI, INDONESIA

FINAL REPORT
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1. INTRODUCTION

The enormous scale, the cultural and economic dimensions, and the conservation impacts of bird keeping have been established by a recent multiagency project led by the Oxford University Centre for the Environment (OUCE) and financed by the Darwin-Initiative. 1-in-5 households keep a songbird and the hobby contributes £42 million to the economies of six cities. Songbird contests provide social spaces where people from all social classes and ethnicities come together and they drive fashions and trends in bird-keeping. These facts were generated from an extensive programme of qualitative and quantitative research in six cities of Java and Bali.

The project mobilised local communities of practice involved in bird keeping and trade to create a prestige-led, voluntary market-based instrument that aims to bring about a switch from keeping wild-caught birds to captive-bred alternatives. A complication in this plan, but also an exciting opportunity, is the finding that farmers on Bali have since 2001 been supplying that market with large numbers of Orange-headed thrush (*Zoothera citrina orientis*) chicks harvested from their agroforests.

Orange-headed thrush is the most prestigious species among bird keepers and demand has caused rolling local extinctions across Java since 1995. The supply of chicks from Bali may be alleviating this situation. An initial assessment by Jepson (2008) found indicators of sustainability. Whilst this practice complicates his idea of promoting birds from certified breeders it provides an exciting opportunity to more rapidly establish ethical and sustainable supply chains of birds supplying Indonesian markets. This is because the breeding of Orange-headed thrush is not yet established and the opportunity to offer a certified wild-harvested product would overcome the difficulty that the most popular and valuable species is the one that breeders are least prepared to supply. Moreover, a big conservation worry is the fact that amateur bird-keepers are unable to distinguish between orange-headed thrush and closely related endemic species found on the islands to the east of Bali and supply chains of the latter are beginning to establish. We currently have no way of tackling this problem and the hope is that the development of a model of sustainability harvesting thrush chicks on Bali could be introduced elsewhere in Indonesia where conservation is struggling to integrate conservation and rural livelihoods imperatives.

This project will contribute to the establishment of a new bird-certification system and the creation of ethical and sustainable supply-chains of birds that maintain and enhance the cultural and economic contributions of bird-keeping, it will explore the feasibility of bird harvesting models that will could reduce threats to forest bird populations elsewhere in Indonesia and contribute to emerging ideas of sustainable landscape management.

This project aims to conduct the following basis research that will enable an assessment of sustainability and generate key ecological knowledge from which more sophisticated research and monitoring programmes can be designed. It comprises four major activities: 1) Mapping the extent of different forest types on Bali; 2) A preliminary study of Orange-headed thrust breeding ecology and movement; 3) Documenting the Orange-headed thrust harvesting practices by farmer; and 4) Communicate the research result with the bird-keeping fraternity.

2. PROJECT AREA AND METHODOLOGY

a. Project area

a.1. Field survey to examine the land cover class which already classified (Newton A.C., 2007) by Forestry Department was conducted at 11 points represent various land cover class, there are Gilimanuk Bay area (8°10'54.70"S ; 114°26'30.04"E), Sumberklampok area (8°10'3.41"S ; 114°30'14.09"E), Pemuteran area (8° 9'22.40"S ; 114°40'1.40"E), Pajahan area (8°19'53.00"S ; 114°59'19.59"E), Manggisari area (8°23'12.50"S ; 114°52'24.80"E), Antosari area (8°29'8.45"S ; 115° 1'16.34"E), Bangli area (8°19'45.58"S ; 115°10'4.12"E), Lemuweh area(8°11'11.48"S ; 115°11'11.71"E), Menanga area (8°22'33.07"S ; 115°26'42.66"E), Bunuting area (8°30'0.30"S ; 115°20'26.30"E), and Ped area (8°40'41.83"S ; 115°32'27.66"E).

A.2. Breeding biology study and documenting harvesting practice were conducted in Pupuan Sub-district, Tabanan District (08o 15' 00" N – 08o 22' 30" N; 115o 00' 00" E – 115o 07' 30" E), and in Busungbiu Sub-district, Buleleng District (08o 15' 00" N – 08o 22' 30" N; 114o 52' 30" E – 115o 00' 00" E), Province of Bali (Figure 1.). Total research area size is 37,594 ha (6, 67% of total area of Bali Island), among that, 13,076 ha is smallholders coffee plantation area (41, 27% of total smallholders coffee plantation area in Bali), and 9,971.66 ha is forest area (7, 63% of total forest area in Bali Island) (Table 1). Using opportunistically observation, we choose four smallholders coffee plantation areas to obtain data on breeding behaviour, territory, and breeding habitat requirement with total area 5, 7 ha.

Coffee plantation is the main area of Orange-headed Thrush chicks harvesting, although in some places harvesting is also practiced in forest areas. Breeding biology study and harvesting practice documentation in forest area could not be implemented, because team did not encounter Orange-headed Thrush during 14 days of survey in forest areas. During a survey accompanied by an Orange-headed Thrush chick hunter, team did not find any Orange-headed Thrush nest.

Figure 1. Project Area

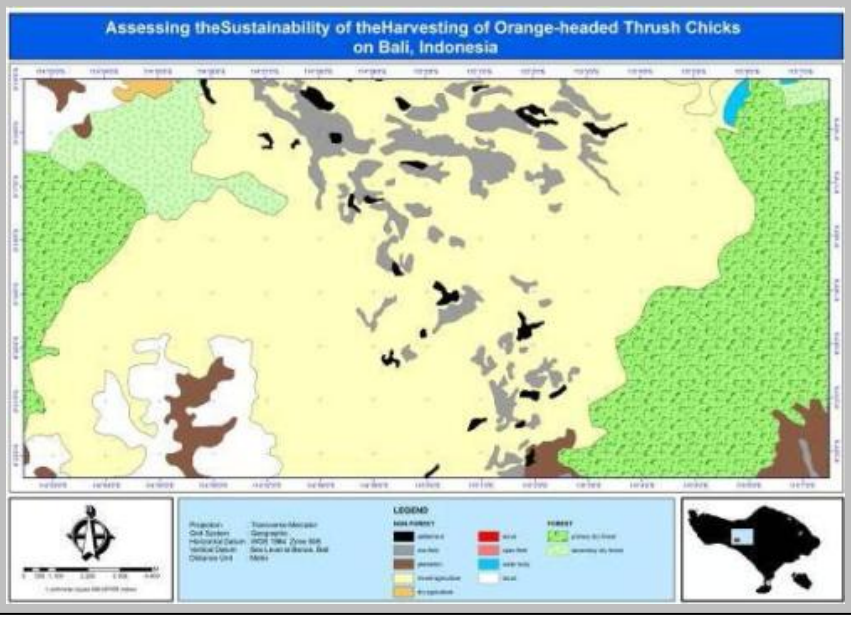


Table 1. Area of smallholders coffee plantation and forest by districts in project area

District	Smallholders Coffee Plantation area (ha	Forest area (ha)	Research area (ha)
Pupuan	7.782	2.687	17.902
Busungbiu	5.294	7.284	19.692

Source: Bali in figures, 2008

Research area is hilly and mountainous, with elevation between 300 m to 2276 m above sea level, and sloped on 15- 40 %. Highest point is at Mount Batukaru in the easternmost part of research area. Research area is on upriver area of Yeh Balian and Yeh Pulukan water bodies, both flows to south coast of Bali, and on Yeh Pancuran and Yeh Sabah water bodies, both flows to north coast of Bali.

According to Meteorological and Geofisical Agency (BMKG), research area is situated on season zone 124, with normal rain characteristic on 2009 dry season, which predicted will start on the first week of May 2009. Rainfall on research area is 3,314.6 mm, relative humidity 85%, and temperature 24.60°C (Bali in Figures, 2008).

b. Data Collection

Fieldwork was conducted from October 2008 through April 2009 and included rapid ground survey around Bali, breeding biology study and documenting the harvesting practice of Orange-Headed thrush.

B.1. Rapid Ground Survey. The team hired a vehicle to go to each points, already marked with Garmin 76CSX GPS. On each point, team took the picture of vegetation cover using Nikon D60 Digital SLR camera, with Nikkor lens 35-70 mm f 1.8-5.5 and 70 – 300 mm f 4 - 5.6. Then we interviewed people living near the area about land use activity history, Orange-Headed thrush encounter and harvest practices. If the respondent was unable to answer those questions, team asked him/her to recommend other people who presumably can give more detailed and accurate answer.

B.2. Breeding Biology. During fieldwork period, team searched Orange-Headed thrush nests within the research area opportunistically (Xin Lu, 2004). Researchers followed a local agent while he harvested Orange-Headed thrush chicks from a farmer's land or plantation. After finding the nest and obtaining permission from the landowner, researcher team searched for other nests in the plantation to find time period of each breeding stage, map bird movements, and measure the success of each successful breeding process (Sutherland W.J. et all. 2004; Debus S.J.S, 2006).

After the completion of a nesting attempt, using nest-site as centre we used 20 metre x 20 metre plot to characterise breeding habitat. For each plot, measurements were taken of its location using GPS Garmin 76 CSx, nest material, height and canopy diameter all tree within the plots to describe the vegetation structure and composition. Abiotic parameter also measured.

b.3. Documenting the harvesting practice. Participatory observation techniques (Sarantakos, 1993) were used to obtain data about supply chain, number of birds traded and harvesting area. Team directly record the transaction of Orange-Headed thrush chicks sold by one Regional agent and local agent. This regional agent was selected because he was one of the pioneering Orange-Headed thrush chick's traders in Bali. He

traded Orange-Headed thrush chicks since 1992. In addition, team also conducted in-depth interviews (Sarantakos, 1993) with other agents.

During our two week stay in one farmer's house, we found that most farmers have a similar Orange-headed Thrush chicks harvesting practice. Then we decided to do questionnaire survey to find out methods on Orange-headed Thrush chick harvesting. Eighteen farmers, selected from one supply chain network, were interviewed.

3. Result and Objectives Achievement Progress

a. Mapping

Pusat Perpetaan Kehutanan Badan Planologi Kehutanan Department Kehutanan has interpreted Landsat image 7ETM+ year 2002-2003 of Bali into three classifications and 17 classes. Full report attached in appendix 1.

b. Study on Breeding Biology and Movement of Orange-headed Thrush

b.1. The Orange-Headed Thrush Breeding Biology

The searching for orange-headed thrush nest begun at 5th November 2008, started from coffee plantation area and surrounding forest. First nest was found at 10th November 2008. The search was continued until the end of March, and the monitoring was ended at 15th April. Total nest found is 58 nests; consist of 29 nests in nestling stage, 21 incubating stage, and 8 at nest building stage. Monitoring was conducted to update the status of those nests (Table 2.).

Table 2. Final status of each nest recorded

First record	Number of nest	Final status after monitoring	Number of nest
Nest building	8	Abandoned	7
		Damaged by disaster	1
Incubating	21	Prey on egg /depredated	15
		Damaged by disaster	1
		Prey on chicks/depredate after hatched	1
		Harvested after hatch	3
		Un detected (Predicted to be stolen)	1
Nestling	29	Damaged by disaster	1
		Harvested	23
		Fledgling/Offspring	2

All individuals who were monitored while gathering nest material or arranging nest materials in their nesting tree were never founded while laying eggs. Failure in nest building stage was determined by six-day monitoring, started after the first encounter. This condition made nest building time unknown. Since the estimation on egg age cannot be done, incubating time is still unknown.

Chick rearing time was determined from two un-harvested nests. Initial estimation on the age of chicks when it was found was based on the information of the harvester/farmers (figures 2.). Two monitored nest are:

i. Nest Code: SPB C 6

SPB C6 Nest was first record at 21 February 2009. Nestling estimation is 6 – 7 days after hatched. The chicks were last observed inside the nest at 26 February 2009 and first observed outside the nest at 2 March 2009, with estimation age 16 – 17 days old. Therefore, it was estimated that the chicks were tended by their mother up to 13 – 14 days after hatched.

ii. Nest Code: SPA B 001

SPA B 001 Nest waste first known at 8 March 2009, nestling estimation 5 – 6 days after hatched. On 14 March, team conducted morphometry and tagging for all monitored chicks, then returned them all to the nest. On 15 March 2009, 06.30 WITA, chicks were still monitored inside the nest. At 09.30 WITA, all chicks were out of their nest. It was estimated that the chicks were tended by their mother up to 12 – 13 days after hatched.

Figure 2. Initial estimation on the age of chicks after hatched

Note: **1.** an egg. **2.** one to two day after hatch. **3.** Four to five day after hatch. **4.** Six to seven day after hatch. **5.** Seven to eight day after hatch. **6.** nine to ten day after hatch. **7.** ten to eleven day after hatch**. 8.** eleven to twelve day after hatch. **9**. twelve to thirteen day after hatch. **10.** Sixteen to seventeen day after hatch.

Total eggs was approximately 145 eggs (n=50 nests). Eighty nine eggs were hatched (n=47 nests), 40 eggs were fell prey on predators (n=15 nests), 9 eggs undetected (n=3 nests), 4 eggs failed to hatched (n=3 nests) and 3 eggs smashed by fallen tree (n=1 nest). Known predator is squirrel (*Tupaia spp.*). However, rat (Rattus spp.), chameleon (*Brochocela jubata*) and domestic cats were also suspected as predators.

Total offspring are six individuals (n= 2 nests), 78 chicks were harvested by farmers (n= 27 nests), two chicks were eaten by predator (n=1 nest), and three chicks died because their nest is struck by fallen trees (n = 1 nest). Observed predators are colubrid snake (*Ahaetulla spp.*) and Sunda Scops-Owl (*Otus lempiji*). Other possible predators are falcon (*Accipiter spp.*), Long-tailed Shrike (*Lanius schach*), and the same as the egg predators.

Figures 3. The Predators

Note:

1. *Otus lempiji*

2. *Ahaetulla spp.*

3. *Tupaia spp.*

4. *Brochocela jubata*

b.2. Nesting attempt movement

The movement of six breeding pairs of Orange-headed Thrush can be mapped on two smallholders coffee plantations belong to Ketut Amarta (figure 4.) and Jero Sumantra (figure 5.). Mapping was conducted after team obtain permission from landowners to explore their coffee plantations. We successfully identified six breeding pairs from several active nests within the coffee plantation area. On 20 and 22 December 2008, we discovered three active nests which are in incubation stage in Ketut Amerta's coffee plantations. Average distance between active nests in Ketut amarta's coffee plantation is 67 ± 3 meter (n = 2). With assume that a half distance between active nests is a breeding territory radius, the area enclose of a pair's territory in Ketut amarta's coffee plantation is 3523 ± 7, 07 m_2.

Meanwhile, three other pairs were determined in Jero Sumantra's coffee plantation from three harvested nests on 27 January 2009, 1 February 2009 and 5 February 2009. All chicks were harvested on age four to eight days. Average distance between active nests in Jero Sumantra's coffee plantation is 72 ± 23 meter (n = 2). The area enclose of a pair's territory of Orange-headed thrush in Jero Sumantra's coffee plantation is 4069, 44 ± 415, 27 m_2.

Orange-headed Thrush will re-nest when their chicks undergo fledging failure (table 3.). The average distance of nest-site placement is 21 ± 14 meter (n = 20). However, the movement of each pairs is still presumptive, since we cannot obtain permission from landowners to catch and band each pair encountered. We also presumed that there are nests built beyond research area, therefore left unmonitored.

Table 3. The number of Orange-headed Thrush Nest during survey period (155 days)

Pair Code	Total Number of nest	Nest final status						
		Nest Failure		Nest Success			Unknown	
		Abandoned nest during nest building	Disaster during nest building	Depredated during incubation stage	Disaster during incubation stage	Harvested	Offspring	Predicted to be stolen
SPJA	4			2		2		
SPJ B	3			1		2		
SPJD	3	1				2		
SPBA	7	1		4				2
SPBB	3		1	1		1		
SPBC	6	1		1	1	2	1	

Figure 4. Movement estimation of three breeding pairs in Ketut Amarta coffee plantation

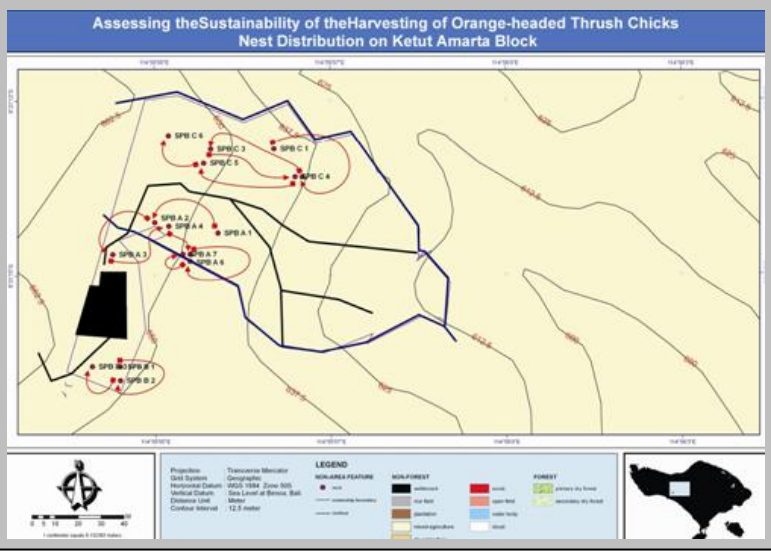
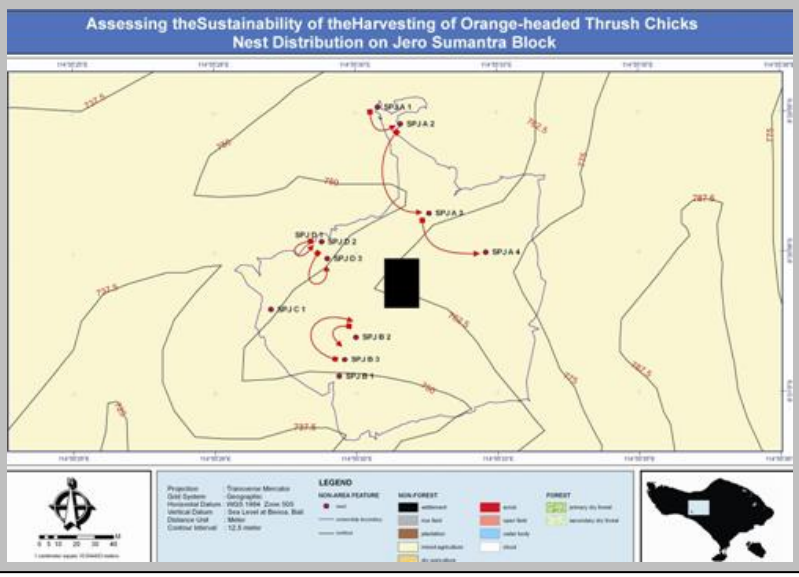


Figure 5. Movement estimation of three parent pairs in Jero Sumantra



b.3. Breeding Habitat

All nests were found at the elevation between 400 – 800 meter above sea level, on the slope of 0_o – 70_o and pH at 5 – 7. Average nest height is 2.99 ± 1.87 meter above ground. Preferred trees for nest are cacao (*Theobroma cacao*) (13 nests), lead tree (*Leucaena leucocephala*) (13 nests), Gliricidia (*Gliricidia sepium)* (13 nests), salak (*Salacca edulis*) (8 nests), coffee (*Coffea canephora*) (3 nests), Jackfruit (*Artocarpus heterophyllus*) (2 nests), cloves (*Syzygium aromaticum*) (2 nests), bamboo (*Bambussa spp*.)(1 nest), banana (*Musa spp.*)(1 nest), Fig tree (*Ficus spp*.)(1 nest) and candlenut (*Aleurites moluccana*) (1 nest). Nest material comprised of dry banana sheath, dry lead tree leaf stalk, dry gliricidia leaf stalks, dry grass, coconut "pipisan", salak fruit scaly skin, moss stem, sugar palm fibre, etc. Although insignificant, plastic wastes were also found.

Figure 6. Some of nesting-site trees

Note:
1. Nest on Salak. **2.** Nest on Cocoa. **3.** Nest on Gliricidia. **4.** Nest on lead tree

Figure 7. Some of nest material sources

Note:
1. Dry banana sheath. **2.** Coconut "pipisan". **3.** Salak fruit scaly skin. **4.** sugar palm fibre

Orange-headed Thrush builds their nest in multistrata coffee plantation area. Vertical structure of various trees on the plantation can be seen from average height differences between each tree (figure 8). Main vegetation, coffee, reached a relatively similar height of 1.30 ± 0.32 meter. Shade trees, gliricidia and lead tree, were regularly trimmed and their average height is 4.12 ± 1.76 meter and 2.37 ± 1.91 meter respectively. Alley crops, such as jackfruit and coconut, are currently grow with average height recorded on sample plot 3.27 ± 1.74 meter and 4.53 ± 4.88 respectively.

Almost all trees are dispersed evenly (figure 9). Only several species, such as fig tree, jackfruit, Indonesian laurel (*Syzygium polyanthum*), and chinaberry (*Melia azedarach*), are found sporadically. Evenly distributed trees with different height made the tree canopy overlapped one another (figure 10).

Figure 8. Average height of tree on Orange-headed Thrush Nesting habitat (m)

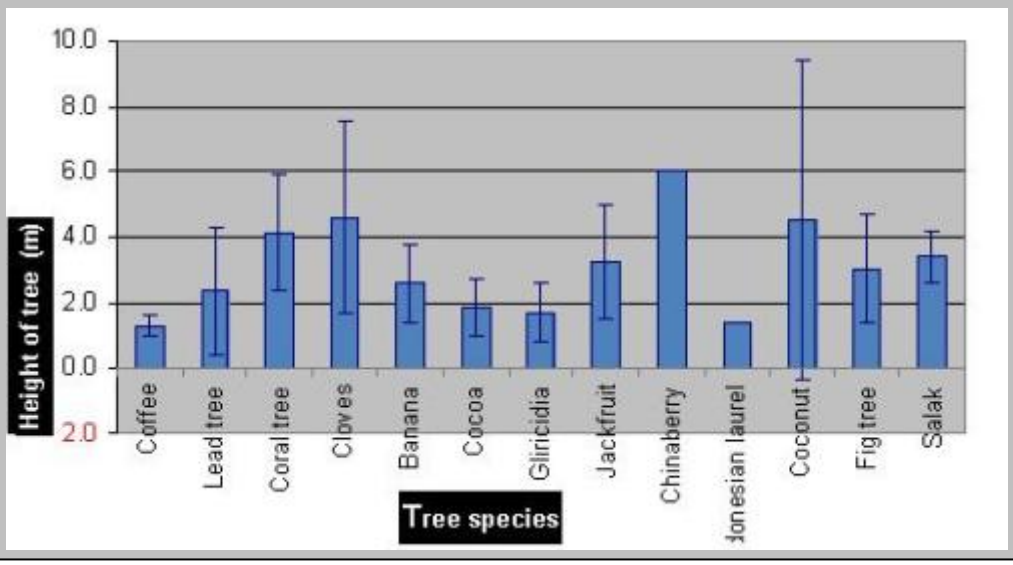


Figure 9. Average Population Density of each Tree species (a tree/m2)

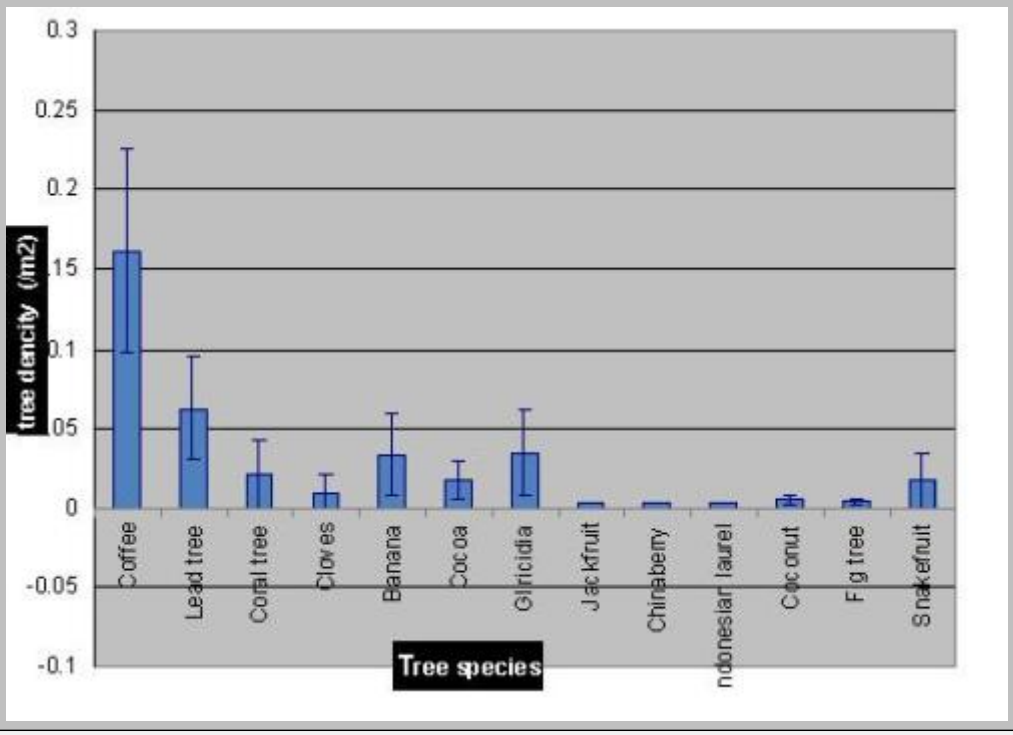
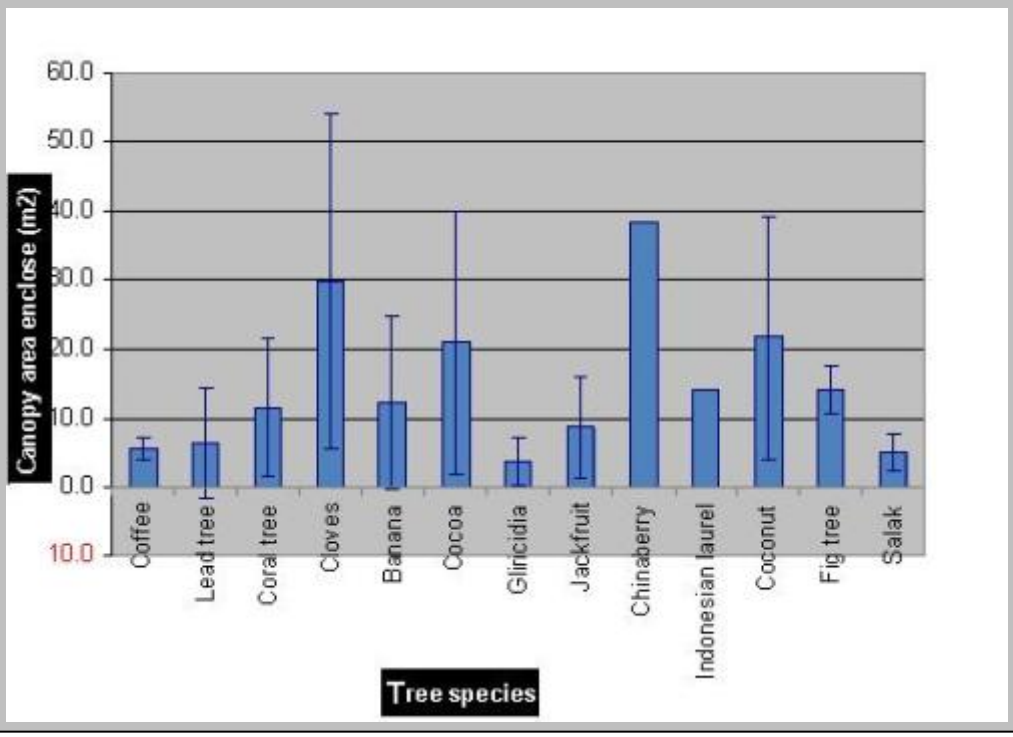


Figure 10. Average of Tree canopy area enclose (m2)



c. Documentation of the Harvesting Practice

c.1. Harvesting method

It is expected that the harvesting of the Orange-headed thrust has been practiced in study areas since 1990. Following the yearly increasing prices of the Orange-headed thrust's chicks; their harvesting areas are being widely expanded to other regions (figure. 11). But a farmer living in Manggissari (Sub district Pakutatan, District Jembrana), who was interviewed while land-use survey was being done, said that the harvesting activities in his village was started in 2005. The other locations with no activities of chicks' harvesting also have been mapped.

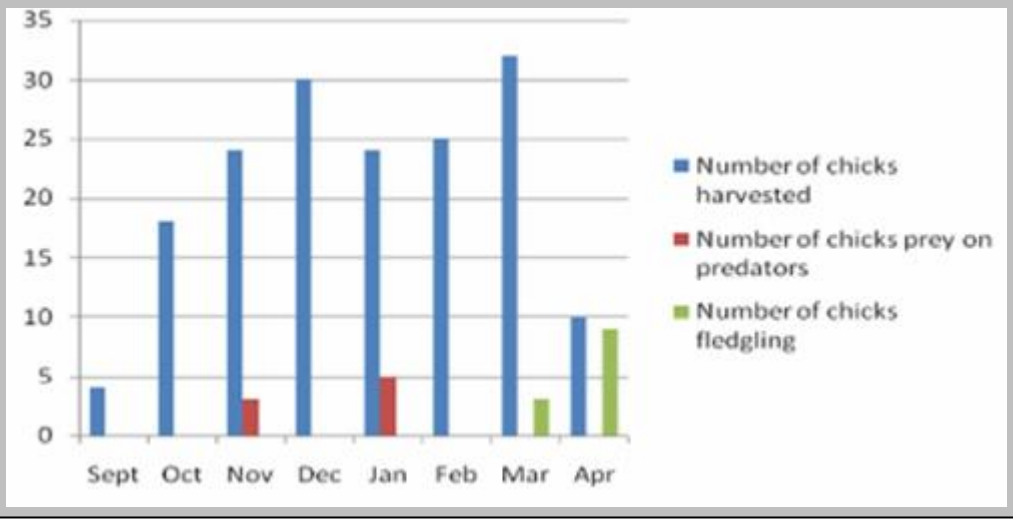
The harvesting activities which used to be practiced only in the smallholder coffee plantation today have been expanded in the forest areas. All of chicks in the founded nests were always taken. Non-harvested nests have been known from the offspring record around the coffee plantation. These fled chicks often threaten to be caught, even though their market prices become lower due to their height mortality after harvested.

The harvesting season of the Orange-headed thrust's chicks begins in the rainy season closed to the end of coffee harvesting activities (figure. 11). However, when the result of research was presented in front of the communities in July 2009, there was a mapped nest which would be harvested. It indicates a newest figure that harvesting activities may be carried out all the year round with the rainy season as the peak season.

Figure 11. The location of Orange-headed thrush harvesting on Bali

Note :
: Smallholders Salak Plantation areas ; : Smallholders coffee plantation areas ; : Smallholders coffee plantation and forest areas ; X : Ares with no harvesting practices

Figure 12. The fluctuation of chicks harvested quantities each month (n = 18 farmers in 25.36 hectare of total areas)



c.2. Supply Chains

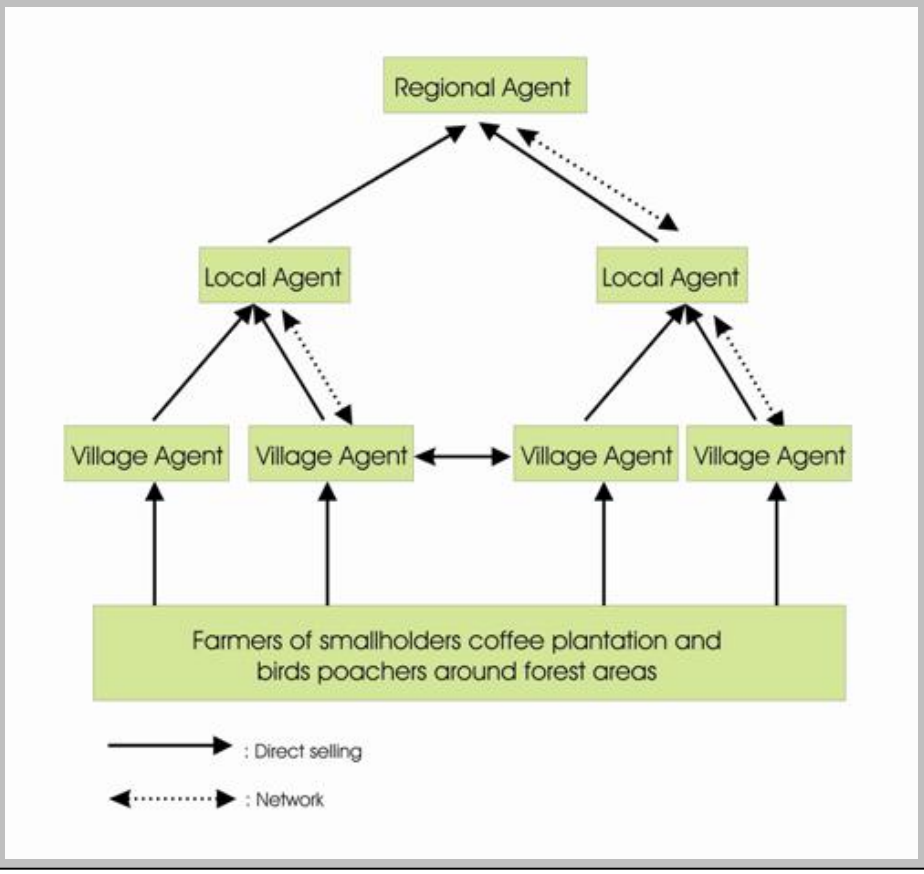
Approximately 68 actors involved in the supply chains of the Orange-headed thrust's chicks are identified in the study areas. Based on their roles in the chains, there are three categorized actors: (a) "*pengecer"* village agent (48 persons); (b) "*pengepul"* local agent (12 persons); and (c) "*pemborong"* regional agent (8 persons) (Table 4). The relationships among categories will be drawn in the figure 13.

Additionally, according to the investments in the supply chains of the Orange-headed thrust's chicks, there are two groups involved: (a) Joint investments and (b) individual investments. Joint investments have established a network among actors. Ten networks may have been formed from the harvesting season of 2008 to 2009. Every season those networks are changeable depend on the forms of investments.

Table 4. Actor's classifications in the supply chain of the Orange-headed thrush chicks

Classification	Roles
Village agent	• Coffee farmers who buy chicks from other farmers. • They often buy the chicks from other village agent. • The village agents heed chicks after the farmer harvest them (approximately 3-15 days after hatching). *Note:* A village agent can hatch eggs with the hatching machines, so he also buys the Orange-headed thrust's eggs to be hatched especially which harvested from forest areas
Local agent	• Seasonal bird traders who sell only the Orange-headed thrust's chicks. • Sometimes they work together with other suppliers to deliver chicks out of regions. • The local agents heed chicks until they are strong enough to be delivered in a further distance (approximately 12-20 days after hatching)
Pemborong	• Bird traders who distribute the Orange-headed thrust's chicks to the markets in Java and Bali • The regional agent heed chicks until they can be sold in a good price (approximately 6-30 days after hatching)

Figure 13. Relationship among the actors



A network sample taken during research shows approximately 14,845 chicks involved in the transaction between a local agent and regional agents. All of those chicks, to which the local agent buys, come from four joint–investment village agents and six individual-investment village agents (figure 14). In this sample, a joint-investment village agent sells 1,874 chicks to that local agent and an individual-investment village agent sells 462 chicks to the same local agent (figure 15). The rest chicks may be supplied by other three joint-investments village agents and five individual-investment village agents. But those are the minimal calculations. Some transactions were not recorded because of limited areas and time during research.

Two interviewed local agents forming other example network said that everyone sells around 10,000 chicks to regional agents. Because of the tight competition in the networks, every successful transaction requires intensive approach among local agent.

Figure 14. Minimal calculations of chicks sold from a local agent to the regional agents during harvesting season of 2008 and 2009

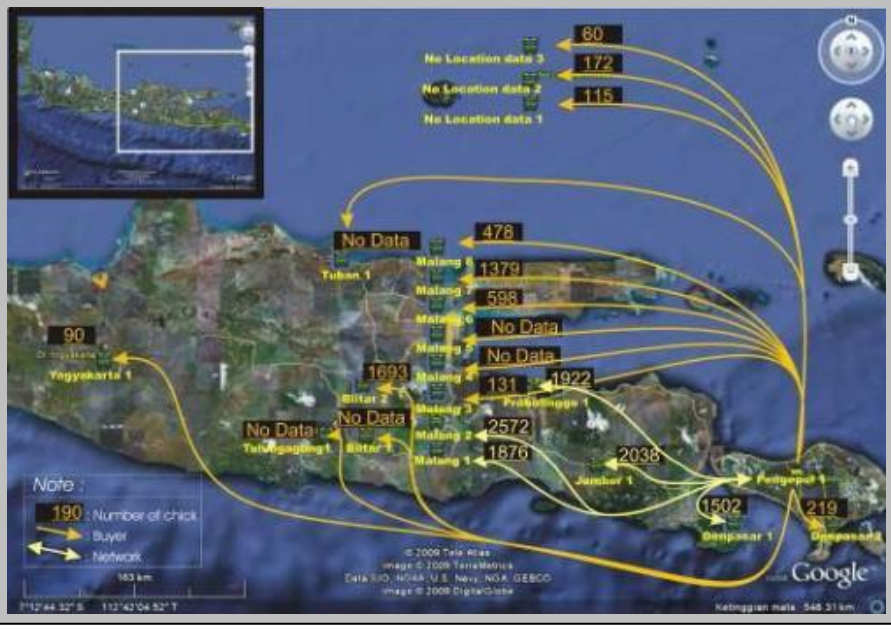


Figure 15. Minimal calculations of chicks sold from village agents to a local agent during harvesting season of 2008 and 2009

c.3. Community regulation

Every *pekraman* villages or traditional villages in Bali have traditional laws called *awigawig*. These laws aim to balance three relationships: (a) relationship between people and their God (*pahrayangan*); (b) relationship among people (*pawongan*); and (c) relationship between people and their environment (*palemahan*). Those relationships are the inside explanations of the *trihita karana* (three cause of prosperity) values.

Unfortunately until the end of field schedules, no specific traditional law regulates the harvesting of Orange-headed thrust's chicks in the study areas. However, every *subak abian* has devised a certain payment or punishment for persons entering and stealing valuable things from other smallholder plantation areas. Mostly the *subak abian* asks the similar three step punishments: Firstly requiring payments approximately three times from the value of stolen things; Secondly returning the stolen goods to the owners; and Thirdly apologizing in front of *subak abian*'s meetings. If a thief neglected those punishments, the *subak abian* would bring this case to the court under the Republic Indonesia's laws.

Subak abian, by which management of smallholder plantation areas are controlled, is one of the community organizations structurally presented under traditional villages. The members of a subak abian are communities of smallholder plantation area owners living in a watershed management areas or sub watershed management areas. Of course, the number of a subak abian's regulations are dynamic and always be developed in accordance to its member agreements.

In the study area, only *Gunung Amerte subak abian* does one apply different punishments to the thieves stealing Orange-headed thrust's chicks. A thief caught while stealing chicks has to pay a fine, which amounts to IDR 10.000 multiplied by 166 members of *Gunung Amerte subak abian* or equals to IDR 1,660,000.

Another regulation developed in the communities prohibits shooting and capturing of mature Orange-headed thrust. This rule has not been regulated by traditional villages or *subak abian* organizations. It exists due to the farmer's initiatives, which are based on spread-information that shooting and capturing of mature birds with mist-net will reduce the number of harvested chicks in smallholder plantation area.

Shooting and capturing activities of mature Orange-headed thrust were found in the region of Unggahan (Sub district Sririt, District Buleleng) and Pujungan (Sub district Pupuan, District Tabanan). An interviewed farmer living in Unggahan recognized that he caught mature birds then released them in a confidential place with the purpose of getting yield from this place in the next harvesting season. But another interviewed farmer from Pujungan said that he shot the mature birds because he frustrated to the thieves who always stole the nests so he never reaped a good harvest from his smallholder plantation area.

d. Communicate the research result to the bird-keeping fraternity

Through various media, we intensively disseminate research results to bird singing contest organizers. One organizer which gave positive response is PBI. We decided to hold an assembly on November 2009. This meeting is planned far ahead time to ensure the presence of all stakeholders. One plan which will be implemented by PBI is ring distribution to farmers who implement sustainable harvesting practices.

PBI also plans to set limit on bird contest for Orange-headed Thrush. Only birds from breeders or harvest under sustainable harvest principles, identified by ring, are eligible for contest. This plan will lead to the certification of contest birds. Ring distribution will also prevent harvesting practices in Forest areas, currently occurred in several places in Bali. Population preservation in forest areas will lead to the sustainability of Orange-headed Thrush. Besides, the presence of population in Forest areas is useful as the source of new breeding pairs for Orange-headed Thrush population in plantation area.

We also have an intensive discussion with bird hobbyists through an internet forum. This forum, with more than total 10,000 users and 1,000 active users, give a positive response. Some forum members, especially those who live in Purwakarta-West Java, has planned to replicate the practice of "breeding in nature" to preserve Orange-headed Thrush in West Java. Similar idea has also discussed intensively by *kicaumania* forum members in Yogyakarta.

On 15 March 2009 (figure 16), I have presented my research results to bird-contest enthusiasts and local contest organizers in Yogyakarta. Boards of PBI and several other clubs also attended the meeting. In addition, this occasion also covered by bird agrobusiness tabloid.

One of my essays, published by www.agroburung.com on 17 March 2009, covered the sustainable harvest practice of Orange-headed Thrush in Bali. The essay also mentioned that support from stakeholders, especially singing bird owners and bird contest organizers, is crucial for the conservation of Orange-headed Thrush. Since the publication, it has received 29 comments from readers, most of them bird owners. My previous article about Orange-headed Thrush conservation efforts had also been published by kabarburung.blogspot.com, on 22 February 2009.

Figure 16. Researcher with some bird-contest organiser after presentation

From left: Bryan (PAPBURI), Hartono (Board of PBI), Rudy (POMYogya), Makarius Sukoco (KMYK-DIY), dan Ige Kristianto (researcher)

4. Discussion

The systems of Orange-headed Thrush chick harvesting practices in Bali is in line with characteristics of sustainable use of wildlife, compiled by Beissinger and Bucker (1992b) (Beissinger 2001). National Certification system for bird breeder, currently being developed, is a potential driving factor for the fulfilment of the following sustainable harvesting characteristics:

1. Harvested species live within the area managed by harvester.

   It is easier to set and enforce harvest limit because one land owner controls the resource. One problem arisen that could hinder the fulfilment of these criteria is the fact that some people harvest Orange-headed Thrush in forest areas, too. A solution is offered by PBI, whose idea is to limit bird contest participant to birds harvested from sustainable practices. Together with other organizers, PBI could distribute rings, which signify birds originated from sustainable harvesting practices, to farmers who harvest Orange-headed Thrush chicks from their own land or plantation only. The number of rings a farmer can receive shall be discussed later.

2. Only age class with low reproductive value are harvested.

   Most farmers harvested only chicks who still in the nest. Traders do not favour older chicks or adults, captured by using mist net, and therefore their selling value is very low. This criterion is formulated to ensure high productivity and population density. Harvest practice should consider parent regeneration. This study shows that a farmer will harvest all chicks from all nests founded throughout the year. The knowledge on Orange-headed Thrush nest preference is getting better resulted in increasing yield. From 18 respondents, nine stated that his harvest is increasing, five decreasing, two stagnant, and two others do not remember.
   We found three reasons why farmers do not pay attention to parent regeneration factor on Orange-headed Thrush harvest practice:
   1) Each year, farmers observe the presence of offspring's in their land. It leads them to believe that those individuals are products of undiscovered nests. These individuals are predicted as new parents.
   2) Farmers do not have information and knowledge in relation to the continuity of orange-headed thrush chick's economic value. Therefore, they were afraid that there would be times when orange-headed thrushes no longer sell or at least their selling price plummets. Therefore, farmers tend to harvest as many as they can.
   3) Farmers do not have information and knowledge on orange-headed thrush productive age.
   Farmers and contest organizers have a high mutual dependency. If suddenly contest organizers stop all Orange-headed Thrush contest, Orange-headed Thrush will lose its economic value. In the opposite, if farmers do not supply Orange-headed
   Thrush anymore, there will be no Orange-headed Thrush contest anymore.
   This bond can be used to ensure the sustainability of Orange-headed Thrush. Both sides can make agreement that will benefit them. Contest organizers should ensure that they would continue Orange-headed Thrush contest if farmers can ensure Orange-headed Thrush production sustainability, for instance, by maintaining parents regeneration.

3. Harvested species complete their live cycle within the managed area, thus easier to monitor and manage for sustainability.

During project period, researcher did not find migration behaviour on Orange-headed Thrush. However, some Orange-headed Thrush sub-species are known to migrate, i.e., *Z. c. citrina*, *Z. c. Innotata, Z. c. Melli, Z. c. Courtoisi,* and *Z. c. Gibsonhilli* (Clement, P., 2000).

4. Product are marketed shortly after harvesting so that long periods in captivity can be avoided. This will minimize harvester loss from post-harvest death and expenses during captive husbandry.

Most farmers (66%) nurtured harvested chicks before sold them to traders. Care was given especially to chicks that were harvested before they reached eight days after hatch. Eight days old chicks gave farmer the optimum price. This practice gives opportunity to put the "ring" as a band of the certified harvested chicks.

5. There are high potential to improve productivity through management activity. Sustainable harvesting practice is not identical to low productivity.

Three from 18 respondents said that they have implemented some innovations to increase Orange-headed Thrush chick's harvest, namely: 1) Placement of Orange headed Thrush nest replicas in several locations, 2) Eradication of known predator of Orange-headed Thrush chicks, and 3) Tilling the land around nests t ease Orange-headed
Thrush parents in getting food (worm). They believe those activities will make Orange-headed Thrush parents stay in their land and re-nest after their chicks harvested.
Canopy structure of coffee plantation resembles those on natural forest. The existence of cow or goat barn in the middle of the coffee plantation ensures the availability of worms, the main food of Orange-headed Thrush.
According to Hairiah, et.al. (2004), although the biomass is lower, the population of worm in multistrata coffee plantation in Lampung, Sumatera is higher than those in forest. The presence of banana trees within the plantation also ensures the availability of nest materials. Banana tree sheath is used as nest materials on 56 out of 58 found nests.
Predation and chick harvesting is two main factors of fledging failure. Nevertheless, a notion that Orange-headed Thrush is a multi-brooded species is emerged. Other widely observed multi-brooded species are; 1) Wood Thrushes (*Hylocichla mustelina*) (Friesen, L.E. et all. 2001 ;), 2) Black Redstarts (*Phoenicurus ochruros*) (Martin W., 2006), and 3) Sagebrush Brewer's Sparrows (*Spizella breweri breweri*) (Mahony N. A. et all. 2001). Thompson B. C. et. all. (2001) recorded as many as 100 scientific writing published on ornithological journals who mentioned about re-nesting or multi-brooded species.
Nest failure on multi-brooded species does not indicate a per capita birth rate of zero, because the breeding pairs can re-nest after a failure and can initiate second or third broods when the previous nests are successful (Driscoll, M. J. L., et al., 2005).
Sensitivity analysis showed that differences in re-nesting interval, nesting success, fledgling per successful nest, and adult and juvenile survival caused variation in breeding-season productivity (Powel L. A., et al., 1999).

6. Species that are fecund and adapted to modified habitat or in earlier succession stages will be easier to sustain and be less susceptible to overharvesting.

Finding of plastic from household waste as Orange-headed thrush's nest material, although at insignificant number, indicates that Orange-headed Thrush is able to adapt to an environment that have intensive interaction with human.

5. Other Works

Every month, *subak* members held a meeting. However, innovations in plantation management did not spread rapidly. Low Orange-headed Thrush regeneration will eventually caused population crash. To prevent such fate, team decided to work tactically. Team documented plantation management innovations practiced by several farmers to maintain the sustainability of Orange-headed Thrush and distributed the results (movie and booklet) to other farmers. Through those media, team tried to raise farmers' awareness on the importance of conserving Orange-headed Thrush. This additional media development has lengthened the project timeline, and contributed to the delay in the reporting as well. Booklet is enclosed in Appendix 2. However, the quality is quite low to avoid large file size.

Documentary movie can be accessed in YouTube:

- First-chapter: http://www.youtube.com/watch?v=9N5Wx5MB5Us,

- Second-chapter:
http://www.youtube.com/watch?v=BDl1qNNfXBM&layer_token=9a31bf3edc784950

6. Recommendation and Future Works

Short term:

1. Harvesting all chicks within harvest area is not a sustainable harvest practice, caused by the decreasing number of breeding pairs. Information on productive age, demography and population trends of Orange-headed Thrush are necessary to determine harvest limit and preserve breeding pair's population.

2. National certification system for bird breeder can be adapted for the development of certification system for Orange-headed Thrush Harvester. Innovations on coffee plantation management practice to increase Orange-headed Thrush chicks harvest can lead them to become in-situ breeder, who is different from usual breeder (ex-situ breeder). Both breeders have similarities on food provision, nest provision and pest/predator control in a controlled environment. The differences lie on the width of controlled area, parents supplying and disease control.

Medium term:

1. Experimental research shall be conducted to study various management practices to increase support capability. This will eventually lead to the increase of breeding pairs numbers, by reducing the territory and range of Orange-headed Thrush. Such researches will help farmers in increasing their income from sustainable harvesting practice.

2. Multi-brooded behaviour notion in Orange-headed Thrush should be analyzed further using more sophisticated method, because if it is true, this behaviour will be very influential to the demography and population trend of Orange-headed Thrush. If Orange-headed Thrush is a single-brooded species who able to re-nest after suffering nest predation, "alternative predator" method should be used to limit harvest quota and ensure its sustainability. Average annual harvest is equal to potential predation from predators eliminated by farmers. This idea should be

examined further, since decline in one predator can increase predation from other predators (Schmidt, K. A. 2008).

Long term:

1. On their efforts to increase Orange-headed Thrush harvest, some coffee plantation owners have similar basic knowledge with those of "land managers", developed by ornithologists at Cornell Lab of Ornithology (Rosenberg, K.V. et. all. 2003; Rosenberg, K.V. et. all. 1999). The difference lies only in the knowledge structuring process. Farmers develop the knowledge as a survival effort. Different knowledge from different farmers can be restructured to create a new construction of science, especially in sustainable natural resource utilization. This knowledge is important in integrating conservation into poverty reduction, especially in Indonesia and other developing countries.

7. Problem arisen and solution adopted

1. Respondents' limited time

Aside from farming, Balinese farmers spend most their time for various religious and traditional activities. Their spare time is only in the afternoon between 12.00 – 14.00, and at night between 20.00 – 21.00. Thus, researchers had only limited time to communicate intensively with them.

Despite religion difference, researchers tried to be involved in various activities. On each traditional and religious activity, researchers took part as photographer and documented their activities. Some documentation was given back to them, resulted in their warm reception of researcher presence. To obtain unbiased data, researcher needed two months to adapt to local condition. This adaptation period was used to perform initial observations and to compile questions.

2. Research object is an economic asset.

Almost all farmers previously forbade researcher team to enter their coffee plantation area. They were afraid that our presence will disrupt breeding process, and they will lose their harvest.

We solved this problem by accompanying traders who entered plantation area to harvest Orange-headed Thrush chicks in the nests. We asked the trader to help us explained our research aim to the farmer. The trader advised us to give some money as collateral to the farmer. If unwanted things happened, the money will be his. It will be returned to us if nothing bad happened.

However, when we asked permission to catch and band Orange-headed Thrush parents, no farmers allowed us. This means we cannot map the movement of Orange-headed Thrush in the plantation. However, from later observation, rather than banding, we propose to use radiotelemetry or satellite transmitter method. Orange-headed Thrush swift movement between brushes and tree litter make observation impossible.

3. Documentation on forest areas harvesting practice

In November, researcher has conducted survey on forest areas. However, we did not encounter Orange-headed Thrush. On February, we obtained information regarding harvesting practice on forest area. Then we decided to repeat the survey, guided by a local hunter. Although we surveyed the area for two weeks, we cannot encounter any Orange-headed Thrush. Orange-headed Thrush chick harvesting in forest area occurred on a shorter period than on coffee plantation area. Therefore, Orange-headed Thrush harvesting practice on forest areas are can only be documented on the beginning of rainy season (September – December) as the local bird poachers suggest us.

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9. Expenditure

Detailed report attached in appendix 3.

10. Project Team

1. Team Leader: Ign.Kristianto M., S.Hut
2. Research support: Arif Faisal
3. Community Organiser: Wisnu Prabowo, S.Hut.

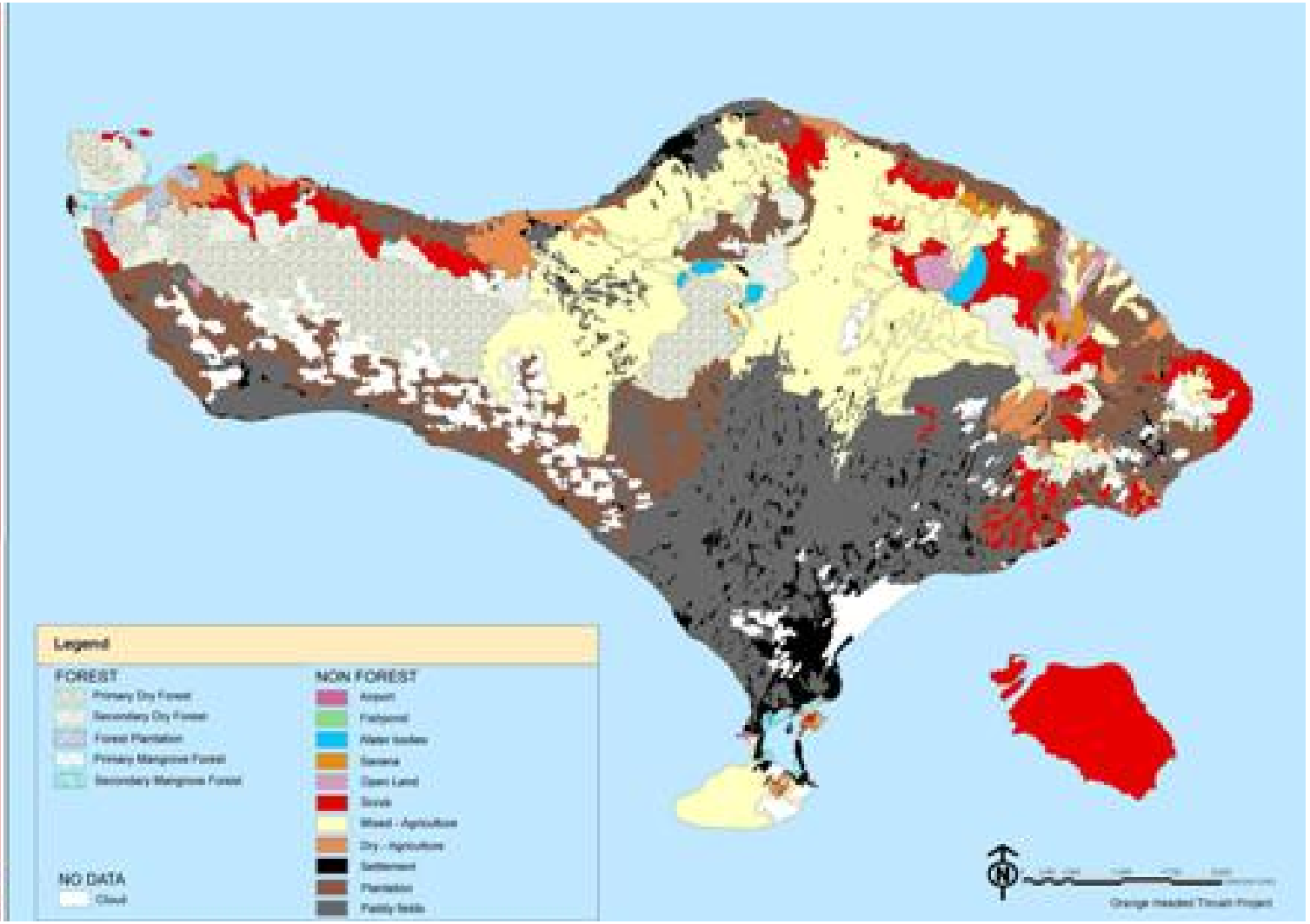
Volunteer:

1. Andri S.Ip.
2. Prastowo Hadi S.Si.
3. Hary Rudyanto
4. Agung Satria
5. Theresia I.
6. Teja Yuwana

Appendix 1.

Mapping the extent of different forest types on Bali

Bali's Land Cover Map



Mapping

Pusat Perpetaan Kehutanan Badan Planologi Kehutanan Department Kehutanan has interpreted Landsat image 7ETM+ year 2002-2003 of Bali into three classifications and 17 classes (table.2).

Table 2. Area of each land coverage class in Bali, based on Landsat Image7ETM+ year 2002-2003

Classification	Class	Area (ha)
No data	Cloud	41,850.52
Forest	Primary Dry Forest	47,082.02
	Secondary Dry Forest	33,586.97
	Primary Mangrove Forest	588.22
	Secondary Mangrove Forest	1,587.49
	Forest Plantation	2,653.21
Non-forest	Mixed - Agriculture	191,645.07
	Dry - Agriculture	17,714.70
	Open Land	5,964.86
	Settlement	27,376.66
	Plantation	85,225.52
	Savannah	2,781.00
	Paddy fields	115,925.63
	Scrub	51,998.73
	Fishpond	325.67
	Airport	151.76
	Water bodies	2,880.83
Total area of Bali Island		629,338.86

Forest Classification

A. Primary Dry Forest Class

This class comprised of lowland forest, hills and mountains which show no signs of logging activities. Natural low vegetation which grew on massive rocks also included in this class.

Primary dry forest stretched from Prapat Agung Mt (310m) in the western tip of Bali to Pohen Mt (2069 m) at the western bank of Bratan Lake. This class is divided into three main polygones, separated by dry - agriculture class in Sumberklampok and mixed - agriculture in the valley between Patas Mt. (1414 m) and Batukau Mt (2276 m).

This class has been there since before 1900. However, its area is constantly decreasing, especially on its slopes. Forest cover loss is mainly due to forest clearing for coffee (*Coffea spp.*), clove (*Syzygium aromaticum*) and coconut (*Cocos nucifera*) plantation. The increasing demand for bricks and tiles also contributed to this loss, since the production of these goods needs firewood (Bali Forest Office, 1991 and Whitten et all., 1999).

Vegetation cover of Evergreen forest in Sepang

Vegetation cover of Sem evergreen Forest in northern Manggissari

Based on elevation, dry season, rainfall and flora, primary dry forest consists of four types (Whitten et. all., 1999):

1. Dry Deciduous Forest

Situated below 500 m above sea level with annual rainfall less than 1500 mm and number of annual dry months are seven to eight months. This type is located around Prapat Agung Mt (310m), in the west part of primary dry land forest class polygon.

2. Moist Deciduous Forest

Situated below 1200 m above sea level, with annual rainfall 1500 – 4000 mm and number of annual dry months is four to six months. This type is stretched from Kelatakan Mt (698 m) to west slope of Sangiang Mt (1004 m).

3. Evergreen Forest

Situated on elevation less than 1200m above sea level, with annual rainfall more than 2000 mm. Dry months are less than two months. Evergreen forest can be found in the north area of primary dry forest class.

4. Semi-evergreen Forest

Situated below 1200 m above sea level with annual rainfall more than 2000 mm. Dry months are two to four months. This type can be found in the south area of primary dry forest class.

B. Secondary Dry Forest Class.

This class consists of lowland forest, hills and mountain range which show signs of logging activities, such as area clearing tracks and deforestation spots.

Vegetation cover of secondary dry forest in north Sawan.

Secondary Dry Forest Class is scattered in many polygones from the west to east of Bali Island. From horizontal point of view, this class is between primary dry forest and plantation or mixed - agriculture class. Not all trees in this class grow naturally in succession process. Some of them are planted by humans. The planting is in accordance with *Tata Guna Hutan Kesepakatan/TGHK* which aimed to enlarge forest area to 31% of Bali area. This is the reason why all Secondary Dry Forest area are inside protected forest area, nature reserve and conservation area.

C. Primary Mangrove Forest Class.

Vegetation cover of primary mangrove forest in Gilimanuk bay

Consists of all mangrove, nipa palm (*Nypa fruticans*) and *nibung* around the coasts which show no logging activities. This class is very narrow although the area is not smaller than before. RePPProT 1999 recorded that total area of primary mangrove forest in Bali is approximately 500 ha. The analysis of Landsat image 7ETM+ 2002/2003 yielded similar figure, 588, and 22 ha. This class exist only in the northeast of Gilimanuk bay and in Biasmentik cape, Nusa Lembongan Island.

D. Secondary Mangrove Forest Class.

Vegetation cover of secondary mangrove forest in Bajul Bay

This class consists of mangrove, nipa palm and nibung forest which show traces of logging activities, marked by lines pattern and/or spots of forest clearing. Secondary mangrove forest class in Bali is mangrove forest which have been planted by humans. The largest plantation area is located at Benoa Bay, which is developed into *Taman Hutan Raya* Ngurah Rai. In Prapat Agung Mt, secondary mangrove forest class encircled a quarter of its area in southeast part. This forest is also served as the connector to the eastern part of Taman Nasional Bali Barat.

E. Forest Plantation Class

Forest Plantation Class consists of the image of trees planted by humans, both in mature state (forest) and saplings. Although the area of this class is very small, forest plantation in Bali begun at 1975 in RPH Pengimunan, where teak (*Tectona grandis*), rosewood (*Dalbergia latifolia*) and mixed wooden trees were planted. Evergreen forest clearing for forest plantation purposes was further implemented in RPH Sumberkima, where Cajeput (*Melaleuca cajuputi*) and rosewood were planted.

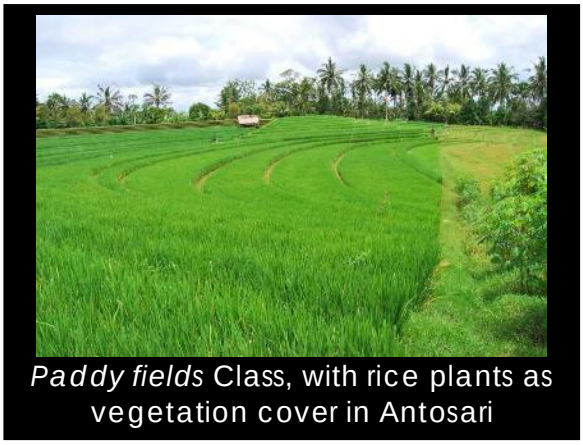
Forest Plantation Class wit mahogany (*Swietenia mahogany*) trees in Palengkong

Relatively large forest plantation class can only be found in those two areas. The rest, a small area situated among plantation class, can be found in northeast Buleleng. Based on its size, land cover interpreted as forest plantation class is forest areas established as production area, while limited production forest area is interpreted as secondary dry forest class.

Non-Forest Classification

A. Paddy Field Class

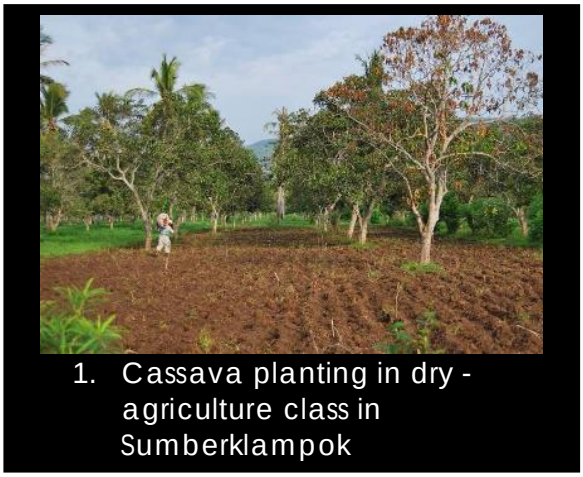
Paddy Field is land image which cover shows agricultural activities, identified by dikes and square patterns. Most paddy field in Bali is in the south, because it is where the contour is more gentle. In physiographic point of view, paddy field class is situated in alluvial valley. Rice cultivation in Bali can be traced back to ninth century. It is one of the most stable and efficient agriculture systems in the world. Field irrigation management in Bali, known as *subak*, is a socio-religious mutual system managed by farmers within one small watershed.



Paddy fields Class, with rice plants as vegetation cover in Antosari

B. Dry – Agriculture Class

Dry - agriculture Class is the image which shows all agricultural activities in dry land, such as *tegalan*, and dry field (*ladang*). Mixed garden dominated with agriculture crops is also classified into this class. This class is scattered among scrubs and open lands. Most are situated in the north areas of Bali, which have steep contours and short watersheds. Crops planted in this class is maize (*Zea mays*), cassava (*Manihot esculenta*), chili (*Capsicum spp.*), and peanuts (*Arachis hypogaea*). Intercropping with plantation trees



1. Cassava planting in dry - agriculture class in Sumberklampok

such as coconut, kapok (*Ceiba pentandra*), fruit tress (such as mangosteen (Mangifera spp.), and rambutan (*Nephelium lappaceum*)) and even timber (Such as *Acacia spp.*) is common. Land cover with dry - agriculture activity can be found only in Buleleng and Karangasem district.

C. Mixed – Agriculture Class.

This class consists of all dry land agriculture activities which mixed with or have interval of scrubs, mixed gardens and former logging area. Mixed – agriculture class is situated in the central part of Bali, from slopes of Batukau Mt (2276 m) to Catur Mt (2098 m) in the west, north and east side. West part of this class is adjacent to paddy field class and secondary dry forest class in east slope of Patas Mt (1414 m). North side is adjacent to paddy field class and plantation class near coastal area. South side is adjacent to paddy field class. Its east side is stretched to the west slope of Batur Mt (1717 m) and Agung Mt (3142 m). Karangasem District has two areas of this class, one is on the south slope of Agung Mt (3142 m), and the other is on the north slope of Seraya Mt (1174). In the west part of Bali, from west slope of Patas Mt (1414 m) westward, this class do not present.

Land cover in this class is dominated by plantation and agricultural commodities. Major commodities in this area is coffee, cacao (*Theobroma cacao*), clove, orange (*Citrus spp.*) and highland vegetables (such as cabbage (*Brassica spp.*), runner bean (*Phaseolus spp.*), and strawberry (*Fragaria spp.*)) intercropped with *gogo* rice. Orange trees is dominant in the east side of this class, and occurred in area with elevation of 1000 m – 2000 m above sea level and annual rainfall between 2000 – 3000 mm. Coffee and clove are often intercropped with salak (*Salacca zalacca*). Other common intercropping plants are coconut, banana (*Musa spp.*) and various fruit trees such as guava (*Psidium spp.*), avocado (*Persea americana*), durian (*Durio spp.*), and mangosteen. Shading tree such as glirisidia (*Gliricidia sepium*), coral tree (*Erythrina spp.*) and White popinac (*Leucaena leucocephala*) are commonly intercropped with coffee and cacao.

Agricultural crops planted in dry fields can be found in northern Badung and northern Gianyar, which formerly are smallholder coffee plantation. The conversion into agricultural crops has been started 25 years ago. Cows, either in pasture or in barn, can also be found in the field.

Coffee plants as the vegetation cover in mixed – agriculture class

Orange tress as the vegetation cover in mixed – agriculture class

Cacao as the vegetation cover in mixed – agriculture clas

Vegetables as the vegetation cover in mixed– agriculture class

Clove as the vegetation cover in mixed – agriculture class

Gogo rice as the vegetation cover in mixed - agriculture class

D. Plantation Class

Plantation class consists of all land covers in the form of plantation, both mature and young. Most of this class is situated at the elevation below 500 m above sea level, in slightly sloped area in western part of north and south Bali, and in the east slope of Agung Mt (3142 m) and Batur Mt (1717 m).

From ten commodities planted by private companies, three of them (coconut, Pará rubber tree (*Hevea brasiliensis*) and cashew (*Anacardium occidentale*) are planted in large area (see Table 2). Nevertheless, compared with smallholder coconut and cashew plantations, that private-managed area is less than 2%. Therefore, it is assumed that most coconut and cashew nut plantation managed by community have been correctly interpreted as plantation, although in average each family only manages area less than 1 ha. Based on data from Horticulture Office, community does not plant rubber.

Special attention should be given to the interpretation of plantation class in the north of Buyan Lake, at the elevation above 500 m from sea level. Based on Google Earth aerial picture, this area is identified as smallholder cloves plantation and not private-managed because private-managed clove plantation is only 38 ha at Pulukan and Tajun.

Table 2. Area of ten plantation commodity at Bali

Commodity	*Area (Hectare)*																
	Private Estates					All Private	Smallholders									All District	*All Bali Province*
	Pulukan	Sangiang	Sendang	Tajun	Bali Anacardia		Jembrana	Tabanan	Badung	Gianyar	Bangli	Klungkung	Karangasem	Buleleng	Kota Denpasar		
Tall Coconut Plants	133	74				207	16,725	15,214	2,53	4,152	2,808	2,862	16,649	8,669	190	69,799	70,006
Cashew nut Plants					171	171			47			391	7574	2146		10,158	10,329
Rubber Plants	94					94											94
Cocoa Plants	20	30		7		57	3675	4968	636	382	327	63	515	1018		11,584	11,641
Robusta Coffee	20	3		16		39	1294	9677	465	304	364	83	848	10774		23,809	23,848
Cloves Plants	35			3		38	3469	3339	286	182	250	312	1002	6739		15,579	15,617
Dwarf Coconut	11	3				14	303	495	234	253	67	131	35	229	59	1,806	1,82
Arabica Coffee				14		14		252	975	174	3935		528	2010		7,874	7,888
Vanilla Plants	2	3		0.5		5.50	266	246	76	51	29	7	53	94		822	828
Hybrid Coconut Plants	3					3	139	59		43	9	3	43	41		337	340

Source: Bali Province Horticulture Office

Coconut Plantation in south Manggisari

Para rubber tree Plantation in south Manggisari

Cloves Plantation in Tajun

E. Scrub Class

Scrub Class is the image of former dry forest which has underwent succession, or area with only a few growing trees, or area dominated by wooden vegetation mixed with natural low vegetation which do not show traces of logging activities. Scrub Class is forest area which is in its succession process. This class is scattered in small polygones along the coasts in Bali Island, except in the south and southwest coast.

Almost all Nusa Penida area is interpreted as scrub class. Based on field survey result, most of vegetation cover in hill slopes dan around settlements is best classified as dry - agriculture class.

Vegetation cover of scrub class in Pemuteran

Vegetation cover of scrub Class in Ped (Nusa Penida Island)

F. Savannah/Grass plain

Savannah class is non-natural forest formation in the form of grass plain, sometimes with few shrubs or trees. Included in this class are also taiga and tundra. This is the hardest class to be interpreted because this class is scattered in various part of Bali. From succession point of view, Savannah class is different from scrub class. Savannah is considered as one of final forms of succession process, while scrub is considered as the initial process. Aside from area east of Gilimanuk Harbour, savannah class can be found in northeast slope of Agung Mt (3142 m).

Savannah land cover in the east of Gilimanuk Harbour.

G. Open Land Class.


Open land on the east slope of Batur Mt.

Open Land Class is the image of lands without vegetation (mountain peak, volcano crater, sandbar, and sand beach), formerly burnt lands, plain open lands, and lands with grass or reeds. Open lands can be found around the peak of Agung Mt (3142 m) and Batur Mt (1717 m). This land is the result of the eruption of Batur Mt (1974) and Agung Mt (1963). Agung Mt eruption is the most dangerous eruptions in Bali. It claimed 1148 lives and 18.000 cattle. (Suryo, 1965 in Kusumadinata, 1979). All vegetation around Pura Besakih in the south slope were covered with ashes and died.
Botanical survey conducted 7 months after the eruption found only three living plants among dead vegetation; *Sambucus javanica* (capr.), *rumput jampang Eleusine indica* (Gram.), and *bandotan* or jukut bau *Ageratum conyzoides* (Comp.).

A year after the eruption of Gunung Agung, there was only 10% of area around Pura Besakih which remains green. Some plants which previously presumed dead grew young shoots. Total 83 plant species were found. Ninety percent of the land remained barren, "as if plastered with cement" (Dilmy, 1965 in Whitten et all., 1999).

H. Settlement Class

Settlement class is the appearance of settlement area, be it city, urban area, rural or village which can be separated. Including in this class is golf court, industrial area and such. The most important feature of this class is its dense lines pattern.

The densest settlements can be found in Denpasar in the south and Singaraja in the slightly sloped area in northern Bali. Settlements in the south and southwest are relatively free from disasters such as floods, landslides, and volcano (Whitten et.al., 1999)


Rural Settlement


Urban Settlement

I. Fishpond Class

Fishpond Class consists of fishery activities around or along coastlines. This class can be found in small area in the northeast of Sumberklampok.

J. Airport/harbour Class

This class is the image of airport and harbours whose size are large enough to be differentiated and delineated.

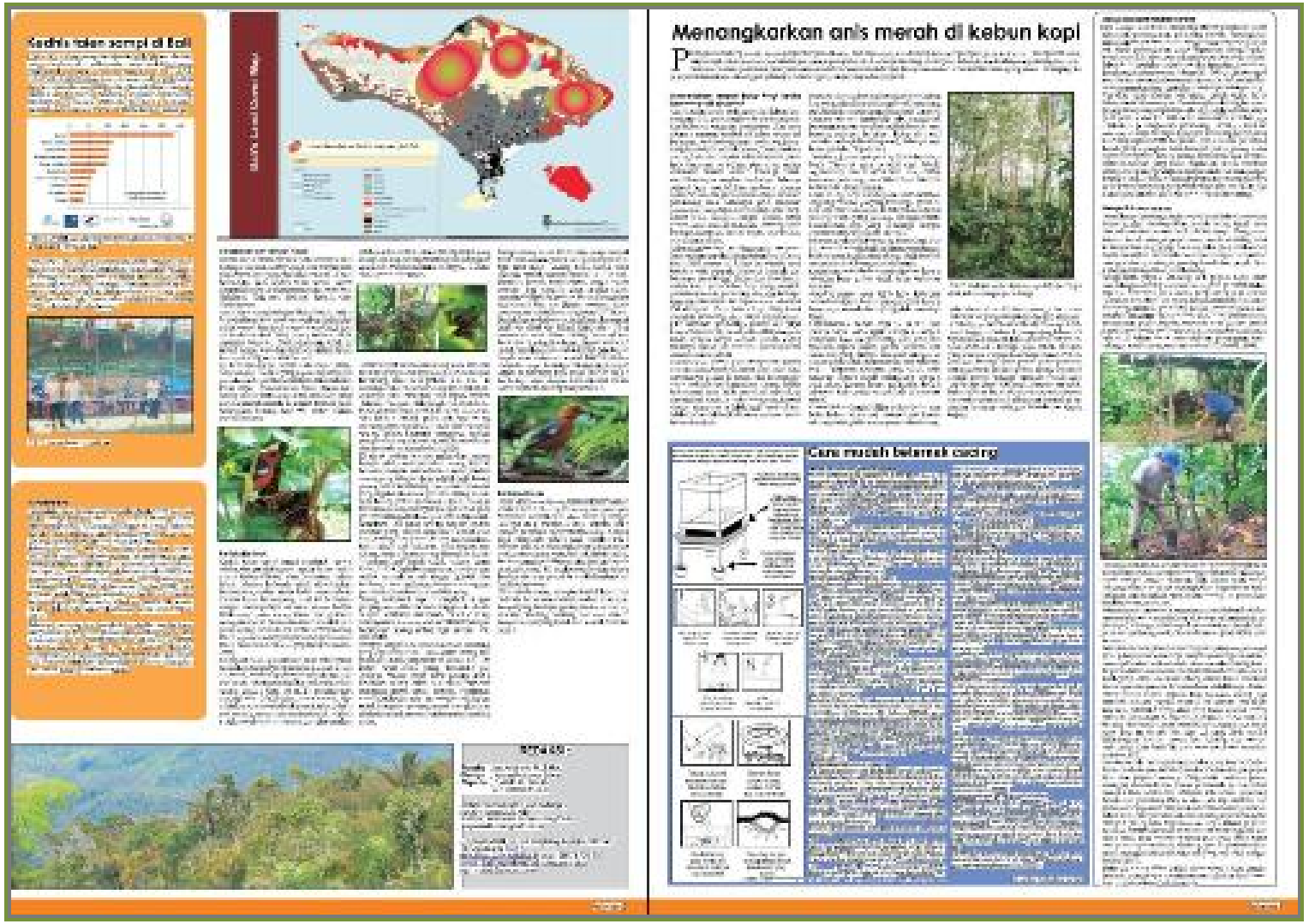
K. Water bodies

This class is the image of natural lakes whose size are large enough to be differentiated and delineated.

Lake Bratan

Appendix 2.


Kedhis Taien Sampi
Rufford
Mengenal Kedhis Taien Sampi


Menangkarkan anis merah di kebun kopi
Cara mudah belanak cepat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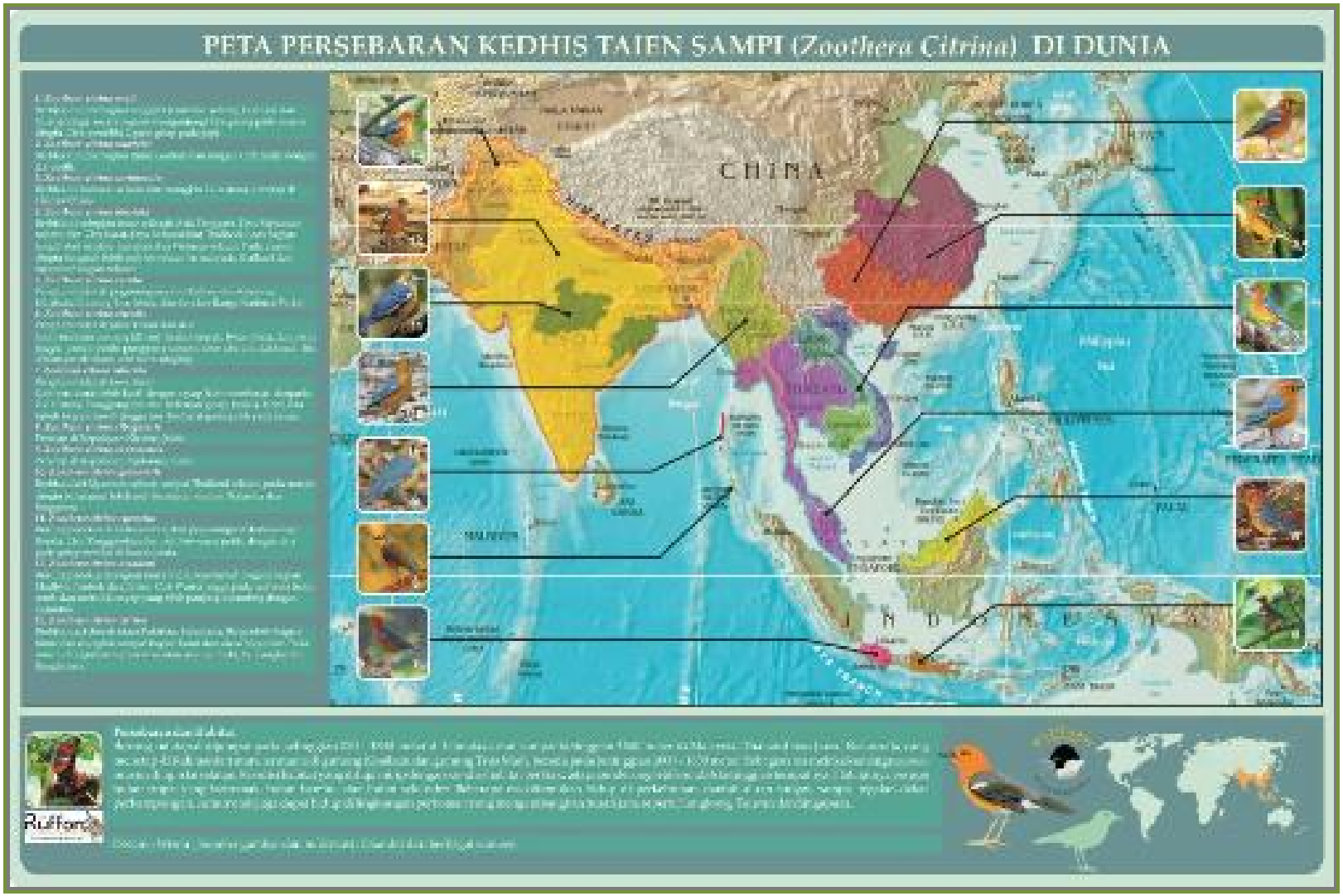
PETA PERSEBARAN KEDHIS TAIEN SAMPI (Zoothera Citrina) DI DUNIA
CHINA
INDONESIA