Chapter 7

A Re-Examination of the Validity of the "Separative and Exclusive Conservation Model": Insights from an Ethnobiological Study in Maluku, East Indonesia

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Additional information is available at the end of the chapter

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Abstract

This chapter aims to examine the validity and desirability of "separative conservation model," a conservation model, which tries to separate human use areas from wildlife habitats to protect "intact nature." In mountain areas of central Seram, East Indonesia, local people have created and maintained various types of human-modified forests (HMFs) through arboriculture. Among them, some of damar forests and forest gardens are distributed inside the Manusela National Park in central Seram. Principally, the Indonesian national park management authority has adopted the "separative conservation model" and basically forbids local arboricultural activities for creating HMFs by cutting wild trees inside a national park. In this chapter, I first describe how the locals have formed HMFs through arboricultural and how resources provided from those HMFs support local livelihood. After that, I describe local knowledge on behavior of a flagship species of Wallacea Moluccan cockatoo and its habitat utilization. Then, I evaluate how some types of HMFs function as habitats for the Moluccan cockatoo by analyzing transect survey data. Finally, I provide implications for future conservation and research.

Keywords: human-modified forests (HMFs), separative and exclusive conservation model, Moluccan cockatoo, arboriculture, participatory transect survey, Manusela, Seram

1. Introduction

A historical anthropologist D.K. Latinis called the subsistence system in Wallacea, including Maluku, Eastern Indonesia, an "arboreal-based economy" [1] because its residents meet most

of their needs through arboreal resource utilization. In the mountain area of central Seram, East Indonesia, where I have been conducting environmental sociological research on local wildlife use, local people are highly dependent on arboreal resources. They have created and maintained various types of human-modified forests (HMFs) through "arboriculture." "Arboriculture" here means the utilization, cultivation and protection of useful arboreal plants. At first glance, mature natural forests in central Seram look like "intact forests," which experience little impact from human activities. In fact, however, there are many HMF patches scattered in the forest area.

Some of those HMFs are located inside a national park. In central Seram, there is the Manusela National Park, which was established in 1989. It has an area of 189,000 ha, covering about 10 percent of the terrestrial area of the Seram Island. One of its main purposes is to help conserve a flagship species in Wallacea, the Moluccan cockatoo (*Cacatua moluccensis*) (**Figures 1** and **2**). The cockatoo is endemic to Seram Island. It is believed that the population of this world's largest white parrot is decreasing due to illegal trapping for pet trade and the destruction of habitat (mainly the destruction of lowland rainforests). Therefore, it is listed in Convention on `International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix 1 and protected under Indonesian law [2].

Basically, the Manusela National Park management authority (Balai Taman Nasional Manusela) has adopted a "separative and exclusive conservation model" (hereafter, "separative model") for its park management. The separative model here means a conservation model that separates human-use areas from wildlife habitats and excludes human activities from protected areas to protect "intact nature." Behind this model lies the implicit assumption that what should be conserved is "intact nature," which is not disturbed by humans, and local people are a (potential) threat to nature. In the mountain areas of central Seram, local people have

Figure 1. A flagship species in Wallacea, the Moluccan cockatoo. Note: Photo by Kai Bancer.

Figure 2. A Moluccan cockatoo drawn on a sign near the national park border. Note: It says 'protect us!' The cockatoo is drawn at the center of the national park's logo and is the primary symbol for the entire park.

created and maintained damar forests (*Agathis dammara*-dominated forests for resin extraction) and forest gardens (mixed tree gardens with fruit trees). Some of these HMF patches are distributed inside the national park. Even though the park management authority seems to give its tacit approval to the locals to manage the HMFs, according to existing Indonesian laws that regulate national park management, HMFs' creation is by cutting wild trees inside a national park.

However, tropical forests in Seram have a long history of human interaction [3]. Large parts of the forest areas inside the national park have been affected by human intervention, including arboricultural practices.

While staying in an upland community on central Seram, I heard from some villagers that Moluccan cockatoos do not live only in kaitahu ("primary" or mature secondary forests situated far from the village settlement and primarily used as hunting and trapping grounds) but are also frequently seen in damar forests and forest gardens. According to the villagers, besides kaitahu, those HMFs are important places for the birds to forage and rest.

Manusela National Park is managed not only for the purpose of protecting Moluccan cockatoo's habitats. However, conservation of the parrot is undoubtedly one of the most important expected functions of Manusela National Park. If, as the villagers mentioned, damar forests and forest gardens truly contribute to providing important habitats for the cockatoo, and if we attach great importance to its conservation, it would be inappropriate to apply a conventional separative model that strictly excludes any human intervention, especially arboriculture, inside the park.

Based on the earlier section, in this chapter, I discuss the validity of a separative model in the context of Seram by evaluating the importance of HMFs as a habitat of a flagship

species, the Moluccan cockatoo. This chapter is organized as follows. After explaining the research site and our data collection methods, in the results section, I first describe how the locals have formed HMFs through arboricultural practices and how resources provided from those HMFs support local livelihood. I also describe local knowledge on the Moluccan cockatoo's behavior, its habitat utilization and distribution. I then evaluate how some types of HMFs are functioning as habitats for the Moluccan cockatoo by analyzing transect survey data. Finally, I provide implications for future conservation and research.

2. Methods

2.1. Study area: Amanioho and Manusela National Park

Seram island is the largest island in the Moluccas (18,410 km^2), East Indonesia, extending approximately 60 km from north to south and approximately 340 km from west to east. The island is located at the north of Ambon, the provincial capital.

This study was conducted in an upland community (given the fictitious name of Amanioho) in the forested interior of central Seram (**Figure 3**). In central Seram, there is a certain amount of forest degradation and deforestation in the lowlands in the northern coastal areas. This is caused by cacao plantations, shrimp farms and transmigration programs as well as commercial logging of meranti (*Shorea* spp.) and merbau (*Intsia bijuga*). In addition, a large forest area in the northern coastal lowlands was cleared for oil palm plantation in 2009. Nevertheless, large tracts of mature natural forest remain in other rural areas in central Seram, especially in the interior mountainous area.

Amanioho is situated in the forest interior of central Seram. In 2012, the population of Amanioho was approximately 320 (60 households). Since there is no navigable roadway, it is necessary to walk to the coastal area where markets are situated. On foot, the journey from Amanioho to the north coast takes between 2 and 3 days, whereas the journey to the south coast takes 1 day (**Figure 4**).

The main economic activities include sago palm (*Metroxylon sagu*) cultivation, banana and root crop agriculture, hunting and trapping and gathering forest products such as edible plants, rattan and wild honey. These activities are primarily conducted for subsistence [4, 5]. The villagers also engage in seasonal migrant work, such as harvesting cloves in the southern coastal area from September to November, and they occasionally sell non-timber forest products (NTFPs) such as parrots and honey in the coastal areas [6].

The village settlement of Amanioho is situated approximately 2–3 km from the nearest boundary of the Manusela National Park. Nearly half the territory of Amanioho is inside the park. As mentioned above, the locals have created and maintained HMFs through arboriculture, and some of the HMF patches are located inside the national park.

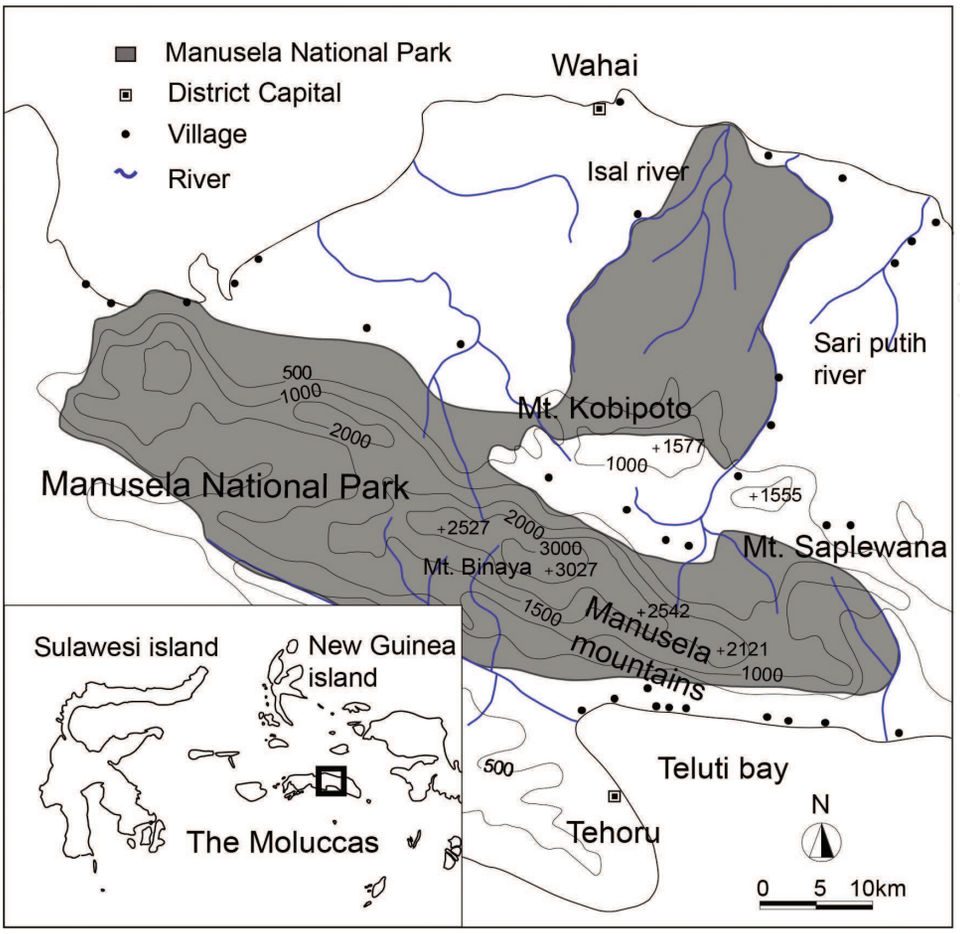


Figure 3. Manusela National Park in central Seram, East Indonesia.

Indonesian Act No.5/1990, concerning conservation of the living natural resources and their ecosystems, and Government Regulation No. 68/1998, on nature sanctuaries and nature conservation areas, stipulate that national parks are managed through a zoning system, and activities that change the ecological integrity of the core zone are forbidden.

Even though the national park management system in Indonesia basically applies a separative conservation model, it also has a mechanism that partially allows local people to use resources inside a national park. The Indonesian national park zoning system comprises several types of zones as shown in **Table 1**. In traditional zones and special zones, the local people can harvest resources under certain conditions (e.g., prohibition on natural tree cutting).

According to the Ministerial Decree on guidelines for the zoning of national parks (p.56/Menhut-II/2006), public consultation involving stakeholders including local people is needed in the process of zonation. Designation of zones in Manusela National Park was implemented in 2011. As shown in **Figure 5**, most of the park is designated as core zones and wilderness zones, where human activities are strictly limited for conservation. Several

Figure 4. The main street in Amanioho (A) and a distant view of Amanioho (B).

upland communities are situated in a peninsula-shaped enclave in Manusela valley. People of those communities are highly dependent on forest resources, and they historically used to use forest areas inside the national park. However, no "traditional zone" is established in the mountain areas where the local people harvest forest resources. The park management

Zone	Allowed activities	Local resource use	Not adjoining core zone
Core	Research, education, building non-permanent supporting facilities.		
Wilderness	Research, education, restricted tourism, building supporting facilities.		
Utilization	Tourism and tourism development, building supporting facilities.		v
Other zones			
Rehabilitation	Rehabilitation-related activities.		
Religious, cultural and historical	Rituals, cultural/historical sites maintenance.		
Traditional	Resource use (NTFPs) in a traditional way.	v	
Special	Accommodating facilities and infrastructure (e.g. roads and electricity), resource/ land use for livelihood.	v	v

Sources: Ministerial Decree 'P.19/Menhut-II/2004 on collaborative management of nature reserves and protected areas, and Ministerial Decree'P.56/Menhut-II/2006 on guidelines for zoning of national parks.

Table 1. Zonation of National Parks in Indonesia.

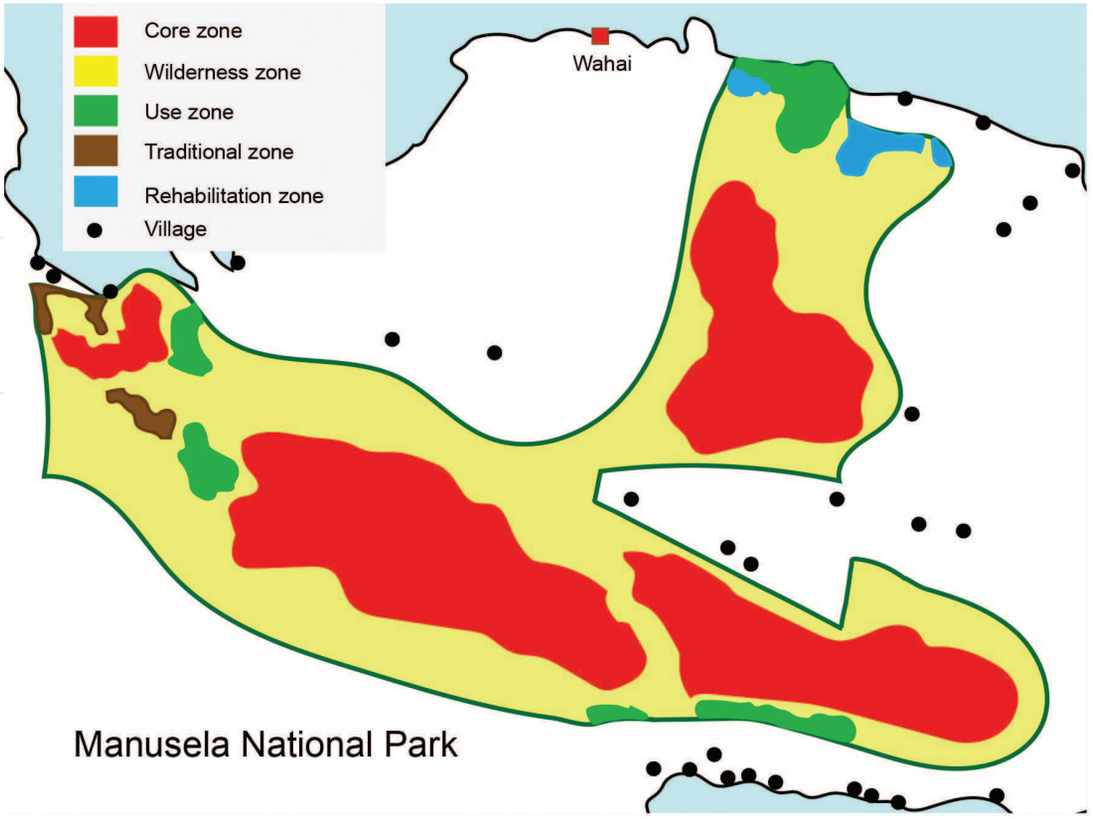


Figure 5. Manusela National Park in central Seram, East Indonesia. Note: Author (MS) drew the map based on 'Peta Zonasi Taman Nasional Manusela, Kabupaten Maluku Tengah, Provinsi Maluku (Zonation map of the Manusela National Park, Central Maluku, Maluku province) (Balai Taman Nasional Manusela, 2011).

authority did not provide sufficient opportunities for the Amanioho people to communicate their aspirations during zone planning.

2.2. Data collection

The following research methods were used. All interviews were conducted by the author using Bahasa (a common Indonesian language) mixed with the local language, *Sou upa*.

- Interviews: Key informants, groups, and working interviews were conducted regarding the formation and utilization of HMFs and on local knowledge of the Moluccan cockatoo's ecology. These interviews were conducted intermittently in October–November 2010, February 2012, September 2012 and March 2014.
- Resource inventory surveys: Through walking interviews with groups of several villagers, the names of plant and animal resources, the usefulness of which was recognized by the villagers, were listed. Focus-group interviews with four villagers (two men and two women) were also conducted to collect data on land usage, where various resources were collected and harvested. As for plant resources, specimens were collected and their scientific

names were identified at the Herbarium Bogoriense, the Indonesian center for science. Initial extensive survey work was conducted in 2003. Supplementary surveys were conducted through the interviews with three village men and two women to complement previous data in October–November 2010, February 2012, and September 2012.

- Food intake surveys: MS distributed self-administered sheets to 14 randomly selected households and asked those household members to record contents of meals they had (food items, land types where those food items are harvested, etc.) for 16 days in 2 research periods, respectively. Data was collected from February 6 to February 21, 2012 (fruiting seasons/wet season) and from September 6 to September 21, 2012 (outside fruiting seasons/dry season). During data collection, MS visited houses of the informants once every 2 days during the longest intervals to check the recorded data and clarified unclear data through interviews.
- Moluccan cockatoo site-mapping surveys: In February 2012, MS conducted a mapping survey to identify locations and forest types of cockatoo sites, that is, places where local villagers reported that the cockatoos are commonly seen or heard. MS interviewed 26 randomly selected villagers regarding the location and forest types of cockatoo sites. After the interviews, MS asked them to visit these sites with small GPS loggers (Trip Recorder 747Pro) to record the geographical coordinates of the cockatoo sites.
- Participatory parrot-transect surveys: These were simple parrot census surveys conducted to understand the cockatoos' HMF use patterns more precisely. MS asked four village males to walk along small forest trails at about 1 km/h with small GPS loggers at specified time periods (from 6:30 to 12:30 and from 14:30 to 18:00) and to record the forest types, when they entered each forest type, when they saw or heard cockatoos and, if possible, the number of cockatoos (**Figure 6**). Before conducting the surveys, the author held a half-day training program to teach the villagers how to record the data. Behavior of the cockatoos may be affected by time. For the purpose of avoiding over-concentration of data in a certain forest

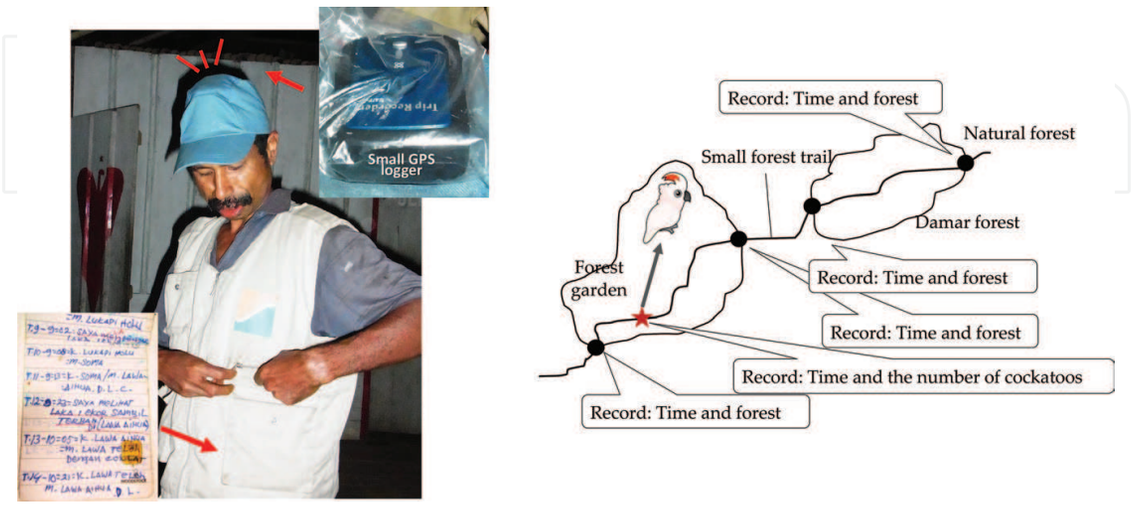


Figure 6. Participatory parrot-transect survey. One of the recorders of the participatory parrot-transect survey (left) and a schematic of the participatory transect survey (right).

type and time period, MS organized survey trips in the following manner. A single transect survey trip took 2 days. On the first day, the recorders walked along forest trails from disturbed forest areas with human-forest mosaics relatively near the village settlements to remote forest areas covered by primary/old natural growth, and they stayed overnight in the forest. On the second day, the recorders walked back along the same forest trails. Since rain may hinder parrot activities, we discontinued the survey during the monsoon. We conducted these surveys during durian (*Durio zibethinus*), jackfruit (*Artocarpus champeden*) and langsat (*Lansium domesticum*) fruiting seasons (in February 2012) and outside the seasons (in September 2012) to avoid a seasonal bias (**Tables 2** and **3**). Data collected by the participatory parrot transect surveys are not available to estimate the population density of the Moluccan cockatoo, but they are sufficient for evaluating relative abundances of the cockatoo in different types of forests.

Route	Length of transect (km)	Lowest altitude (m)	Highest altitude (m)	Number of times of survey	
				Fruiting season (Feb. 2012)	Non-fruiting season (Sep. 2012)
Route-1	9.4	860	1190	8	8
Route-2	11.3	800	990	6	10
Route-3	8.5	840	1410	10	10
Route-4	5.6	790	1140	10	10
			Total	34	38

Source: Fieldwork.

Table 2. Participatory transect surveys.

Forest type	Fruiting season (m) (Feb. 2012)	Percentage (%)	Non-fruiting season (m) (Sep. 2012)	Percentage (%)
Primary'/old secondary forest	123,989	45	157,887	47
Damar forest	39,616	14	51,322	15
Forest garden	42,973	16	39,674	12
NTFP collection forest	19,428	7	24,607	7
Old fallow forest	9031	3	9540	3
Bamboo grove	18,059	7	24,620	7
Cacao garden	5817	2	8825	3
Sago grove	18,177	7	20,083	6

Source: Fieldwork.

Table 3. Length of all surveyed transects (m).

3. Results

3.1. Formation and utilization of human-modified forests

The locals classified land types into at least 13 categories (**Table 4**). Land categories marked with X are HMFs formed through arboriculture.

Among the types, forest gardens and damar forests are important for interrelationships between humans and Moluccan cockatoos.

Land types (Folk categories)		HMFs	Descriptions
1.	Home garden and residential area (amania)		Residential land and home gardens with coconut palms, betel nut palms and various herbs.
2.	Intensive root crop – vegetable garden (lela)		Intensively managed garden, where the main crops are taro, cassava, sweet potato, vegetables, tobacco, sugar cane, etc.
3.	Extensive banana – taro garden (lawa aelo)		Extensively managed garden with banana and taro.
4.	Forest garden (lawa aihua)	X	Mixed tree garden with both fruit trees (durian, langsat, jackfruits, etc.) and wild trees.
5.	Sago grove (soma)	X	Sago palm (*Metroxylon sagu*) grove that supplies sago starch, which is a staple food for local people. Sago (*Metroxylon sagu*) grove. Local people also use sago groves as places to collect edible wild plants.
6–7.	Cultivatable land and fallow forest (lukapi)		Cultivatable land where huge roots of trees have decayed, and fallow forest that was formed in the ex-lela and ex-lawa.
	6. Young fallow forest (lukapi holu)	X	Fallow forests with relatively small young trees that can be cut down by a machete (parang).
	7. Old fallow forest (lukapi mutuani)	X	Fallow forests with relatively large trees that cannot be cut down by a machete.
8.	Itawa forest (Itawa harie)	X	Litsea mappacea-dominated forests that are used as a trapping ground for edible wild birds.
9.	Cacao garden (dusun cokorat)	X	Cacao (*Theobroma cacao*) -dominated gardens. Most of them spring up in fallow land.
10.	Bamboo forest (dusun bambu)	X	Bamboo grove formed through transplanting. Several species of bamboo are used as handicraft materials, fuel wood, and cookware. Bamboo shoot is also collected.
11.	Damar forest (kahupe hari)	X	Resin extraction forest dominated by the *damar* tree *(Agathis dammara*).
12.	NTFP collection forest (airima hari)	X	A forest located relatively close to village settlements, and they are used for collecting NTFPs such as construction materials, fuel woods, medical plants and wild edible plants.
13.	Primary'/old secondary forest (kaitahu)	X	A primary or mature secondary forest situated far from the village settlement and thought of as ground that is primarily used for hunting and trapping game animals. Artificial gaps are made for trapping cuscus.

Source: Fieldwork.

Table 4. Folk land categories.

Damar forests are dominated by *Agathis dammara*, which has been used for resin (damar is a fuel for lamps and kindling) collection. These are formed through selectively protecting seedlings as well as young trees that are growing naturally, and they are patchily distributed in primary and old secondary forests. Felling and barking of *Agathis dammara* is strictly forbidden.

Forest gardens are mixed fruit tree gardens with durians (*Durio zibethinus*), langsats (*Lansium domesticum*), jackfruits (*Artocarpus champeden*) and so on. Forest gardens are formed through planting and protecting seedlings as well as young trees growing in the wild; the seeds are mainly dispersed by wild bats. Forest gardens are patchily distributed in mostly old secondary forests. These HMFs are less intensively managed. As a result, forest gardens have no clear boundary and are mixed with many wild plants.

Figure 7 shows the number of plant resources and total use scores, which indicate the number of uses of the plant resources in each land category. This indicates that non-timber forest product (NTFP) collection forests, forest gardens and sago groves provide relatively diverse plant resources used for various purposes, including food and medicine. **Figure 8** shows the number of animal resources usually captured or commonly seen in each land type. This indicates that the locals utilize a variety of animal species that enter or live in these HMFs. The locals have created various types of HMFs, and this enables them to enjoy diverse plant and animal resource utilization.

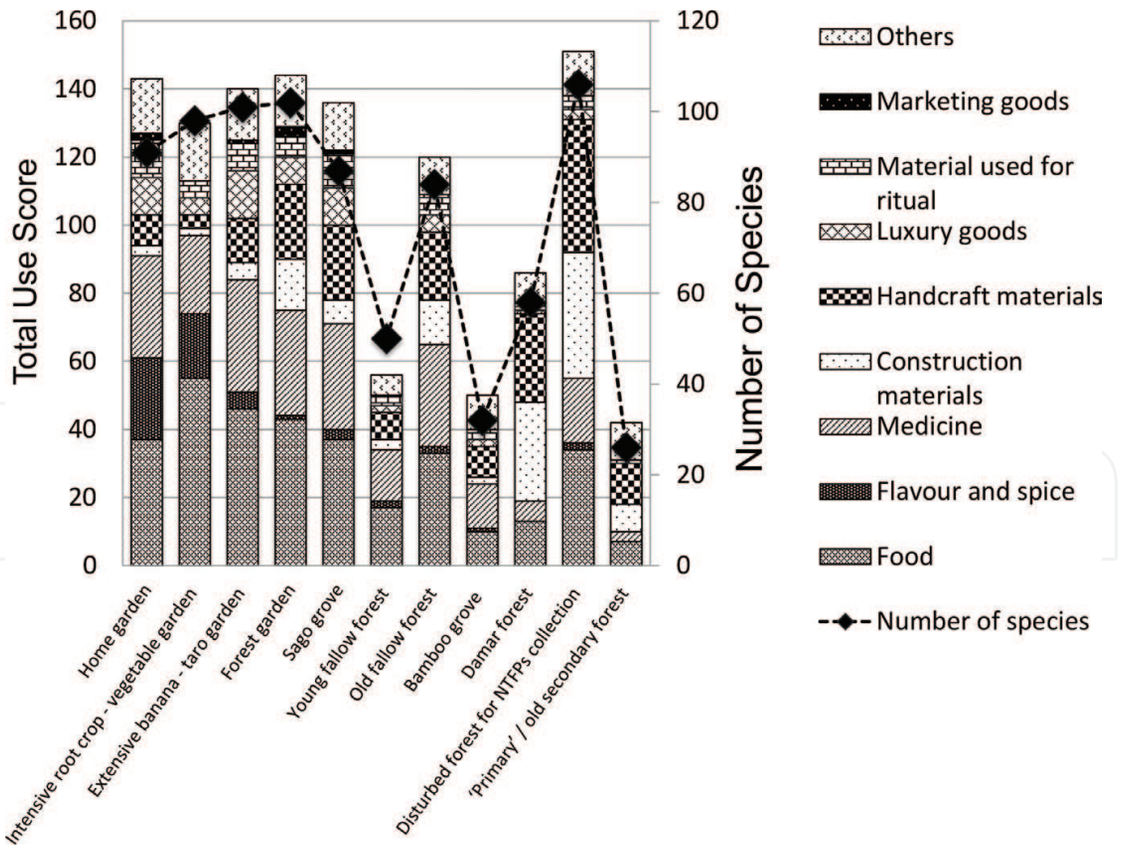


Figure 7. Plant resources. Source: Fieldwork. Note 1: The 'Total use scores' were counted based on the number of uses. For example, the total use score of cassava for food is 2 because besides its root, the leaves of cassava can also be eaten. Note 2: The data for the Itawa forest and cacao garden were deficient.

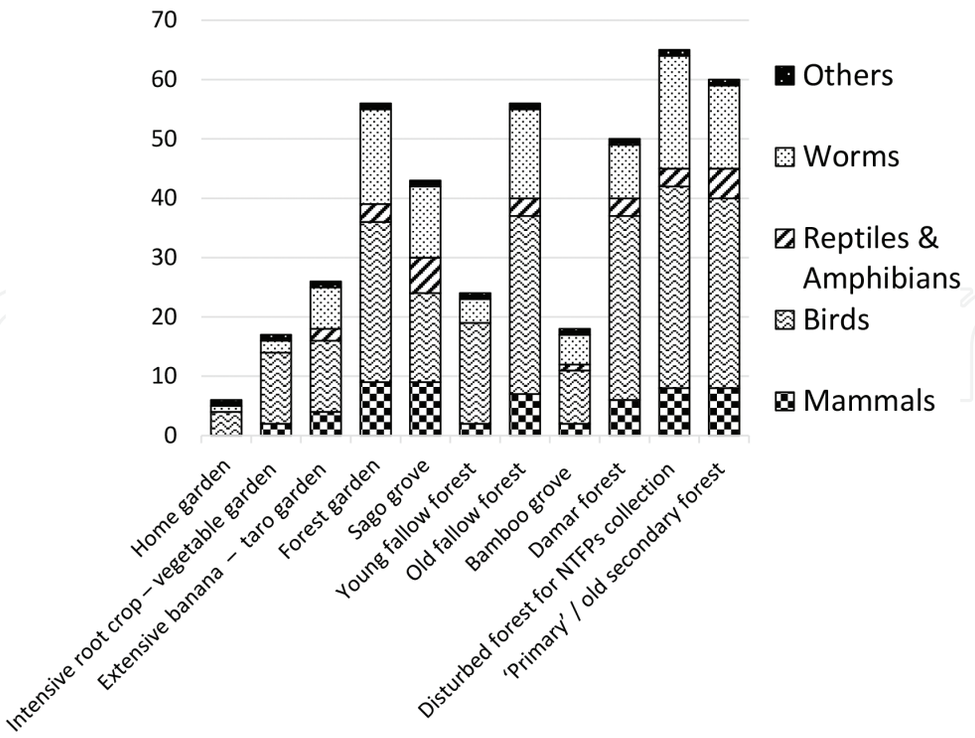


Figure 8. Animal resources. Sources: Fieldwork. Note 1: These animal resources are mostly used for food. Note 2: 'Others' includes snails and honey.

Here we look at how resources provided from HMFs support local diets. **Figure 9** shows the result of the food intake surveys. Bars indicate the number of food items that were consumed by 14 households during the 2 periods by land types. As shown in the graph, the local people harvest diverse food resources in various types of lands. During both survey periods, sago grove, old fallow forest and NTFP collection forest provided relatively many food resources. In the fruiting season for durian, jackfruit, langsat and so on, the locals consume lots of food resources harvested from forest gardens. Creation and maintenance of diverse HMFs contribute to enriching local diets.

3.2. Local knowledge of parrot ecology

3.2.1. Behavior and habitat utilization of Moluccan cockatoo

According to the villagers, during the night, the cockatoos roost in large trees, such as those locally called "kahari" (*Sloanea* sp.) and "raruka" (*Elaeocarpus rumphii)*, in primary and old secondary forests. After sunrise, they fly to feeding areas; they return to the same roosting sites before sunset.

In the morning and evening, they forage new shoots of rattan (*Calamus* spp.), swarms of moths in trunks of dead trees and fruits such as "kahari" and "raruka" in primary and old secondary forests (the fruiting seasons of "kahari" and "raruka" are unknown). They also forage other fruits such as "tatola" (*Homalanthus novoguineensis)*, "ulia" *(Spondias cytherea)* and "masapa" (*Syzygium* sp.) in old fallow forests and forest gardens; fruits of *Agathis dammara* in damar forests; and "hakia" (*Magnolia candollei)*, which also grows in damar forests. These trees do not have specific fruiting seasons. The cockatoos use these food resources all year.

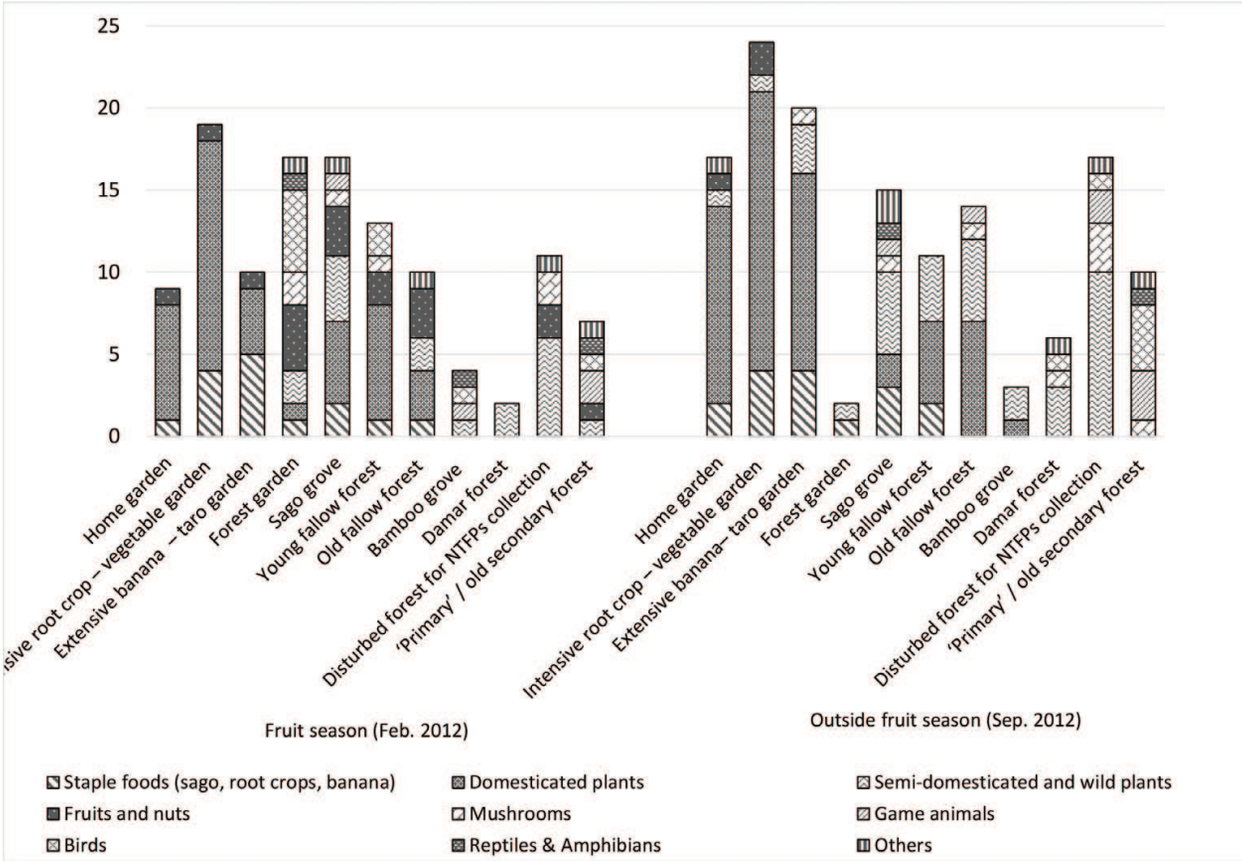


Figure 9. Number of food resources harvested in each land category. Source: Fieldwork. Note 1: Food resources consumed as a snack, luxury items (e.g. tea, coffee, tobacco, betel nuts etc.), spices, flavors and oil are not included. Note 2: 'Semi-domesticated plants' here mean (1) herbaceous and arboreal plants that are planted (transplanted) by humans and less intensively managed after planting, and (2) herbaceous and arboreal plants that grow naturally, but the growth of which is encouraged by humans through weeding, cutting underbrush and vines, etc.

During the durian, jackfruit and langsat fruiting seasons, the cockatoos frequently fly to forest gardens to eat the fruits of these trees. They also frequently use damar forests to nest in hollows of large dead damar trees (**Table 5** and **Figure 10**).

3.2.2. Forest types and distribution of the cockatoo sites

The map in **Figure 11** indicates the "cockatoo sites" recognized by the randomly selected 26 villagers, as those where Moluccan cockatoos are frequently and commonly seen or heard. As shown on the map, the cockatoo sites are distributed over a wide area, including areas relatively near the village settlement and some of HMFs inside the national park. A total of 78 cockatoo sites were listed. Among them, 42 sites are damar forests, and 25 sites are forest gardens (including forest gardens mixed with *Agathis dammara* trees). Of those, 16 sites in damar forests and 3 sites in forest gardens are situated inside the national park (**Table 6**).

The result of the Moluccan cockatoo site-mapping surveys seems to indicate that the cockatoo uses damar forests and forest gardens as important parts of their habitats. However, it is still unclear whether those HMFs are truly functioning as important parrot habitats because of the

Forest type	Utilization	Season
Forest garden	• Eats fruits of durian, langsat, jackfruit	Jan–May
	• Eats tatola (*Homalanthus novoguineensis*), ulia (*Spondias cytherea*), and masapa (*Syzygium* sp.)	All year around
Damar forest	• Eats fruits of damar tree (*Agathis dammara*) and hakia (*Magnolia candollei*)	All year around
	• Nests in tree hollows of large dead damar tree	

Source: Fieldwork.

Table 5. Utilization of human-modified forests.

lack of objective and quantitative data. Therefore, I next analyze the relative abundances of Moluccan cockatoos by forest types.

3.2.2. Relative abundance of Moluccan cockatoos

A relatively high abundance of Moluccan cockatoos was observed in primary and old secondary forests during time period 1 and in damar forests during time periods 2 and 3 in both the fruiting (February 2012) and non-fruiting (September 2012) seasons. During the fruiting season, the cockatoos' abundance in forest gardens during time zones 2 and 3 is relatively high (**Table 7** and **Figure 12**). On the other hand, their presence in other forest types (NTFP collection forest, cacao garden, bamboo forest and sago grove) is very low in both seasons.

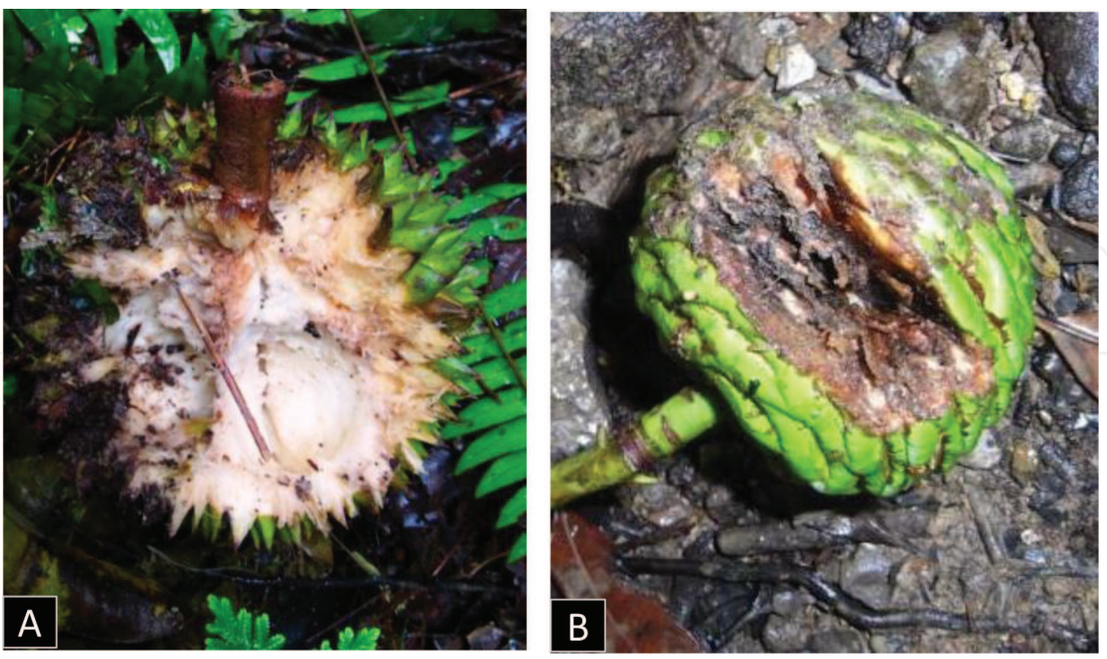


Figure 10. Feeding scars of Moluccan cockatoo on the fruit of durian (A) and *Agathis dammara* (B).

Forest types	Number of sites	Number of sites inside the National Park
Primary/old secondary forest	11	3
Damar forest	42	16
Forest garden	19	2
Forest garden mixed with damar trees	6	1

Source: Fieldwork.
Note: 78 cockatoo sites were identified through the interviews with 26 villagers (Feb 2012).

Table 6. The results of the cockatoo site surveys.

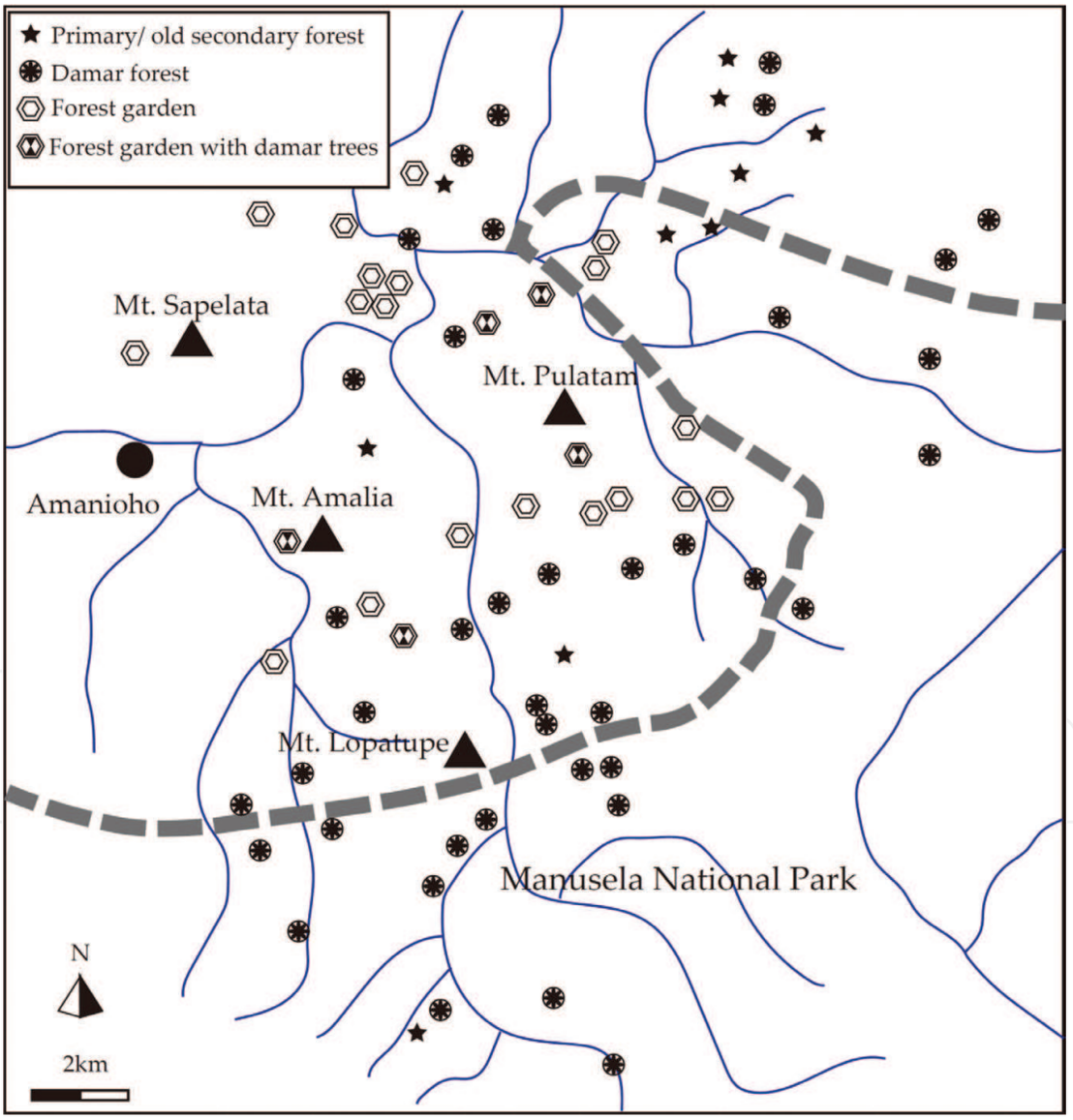


Figure 11. Sites where the Moluccan cockatoos are frequently seen or heard.

Forest type	Time zone-1 (6:30–8:00)	N	Time zone-2 (8:00–9:00)	N	Time zone-3 (9:00–10:00)	N	Time zone-4 (10:00–11:00)	N	Time zone-5 (11:00–12:30)	N	Time zone-6 (14:30–16:00)	N	Time zone-7 (16:00–17:00)	N	Time zone-8 (17:00–18:00)	N	P
Fruit season (Feb. 2012)																	
Primary/old secondary forest	2.88	27	0.94	25	0.21	28	0.24	27	0.00	33	0.72	26	0.21	20	0.12	15	0,001***
Damar forest	0.81	30	1.29	14	0.34	11	0.00	13	0.00	7	1.62	8	0.27	13	0.86	22	0,308
Forest garden	1.19	35	1.20	25	1.08	14	0.18	19	0.59	17	0.21	13	0.00	20	0.06	20	0,052*
NTFP collection forest	0.00	4	0.00	9	0.00	12	0.00	7	0.00	8	0.00	9	0.00	15	0.00	8	1000
Old fallow forest	0.00	15	0.00	6	0.00	3	0.00	3	0.00	6	0.00	3	0.00	6	0.00	9	1000
Bamboo grove	0.00	12	0.00	19	0.00	14	0.00	8	0.00	6	0.00	10	0.00	19	0.00	10	1000
Cacao garden	0.00	9	0.00	2	0.00	1	0.00	14	0.00	14	0.00	6	0.00	2	0.00	5	1000
Sago grove	0.30	21	0.00	14	0.00	9	0.00	10	0.00	18	0.00	18	0.00	6	0.00	14	0,286
P	0.009***		0.029**		0		1		0		0.044**		0		0		
Outside fruit season (Sep. 2012)																	
Primary/old secondary forest	2.29	34	1.08	24	0.47	25	0.45	33	0.10	39	0.26	24	0.51	29	0.43	28	0,010**
Damar forest	0.97	40	0.00	14	2.03	10	0.45	11	0.00	12	1.10	12	0.36	19	0.31	30	0,036**
Forest garden	0.18	31	0.30	22	0.85	12	0.73	11	0.00	19	0.00	17	0.09	17	0.00	17	0,747
NTFP collection forest	0.00	4	0.00	4	0.30	12	0.00	12	0.07	13	0.00	10	0.00	13	0.00	4	0,412

Forest type	Time zone-1 (6:30–8:00)	N	Time zone-2 (8:00–9:00)	N	Time zone-3 (9:00–10:00)	N	Time zone-4 (10:00–11:00)	N	Time zone-5 (11:00–12:30)	N	Time zone-6 (14:30–16:00)	N	Time zone-7 (16:00–17:00)	N	Time zone-8 (17:00–18:00)	N	P
Old fallow forest	0.00	11	1.05	17	0.00	2	0.00	3	1.07	9		0	0.00	9	0.00	12	0,763
Bamboo grove	0.00	17	0.18	22	0.00	11	0.00	10	0.00	15	0.00	9	0.00	16	0.00	20	0,726
Cacao garden	0.00	21	0.00	8	0.00	2	0.00	7	0.00	17	0.00	9	0.00	5	0.00	14	1000
Sago grove	0.00	25	0.00	11	0.00	20	0.00	5	0.06	27	0.00	19	0.00	3	0.00	18	0,809
P	0.000***		0.000***		0.008***		0		1		0.081*		0		0.054*		

Source: Fieldwork.

Note 1: Kruskal-Wallis test.

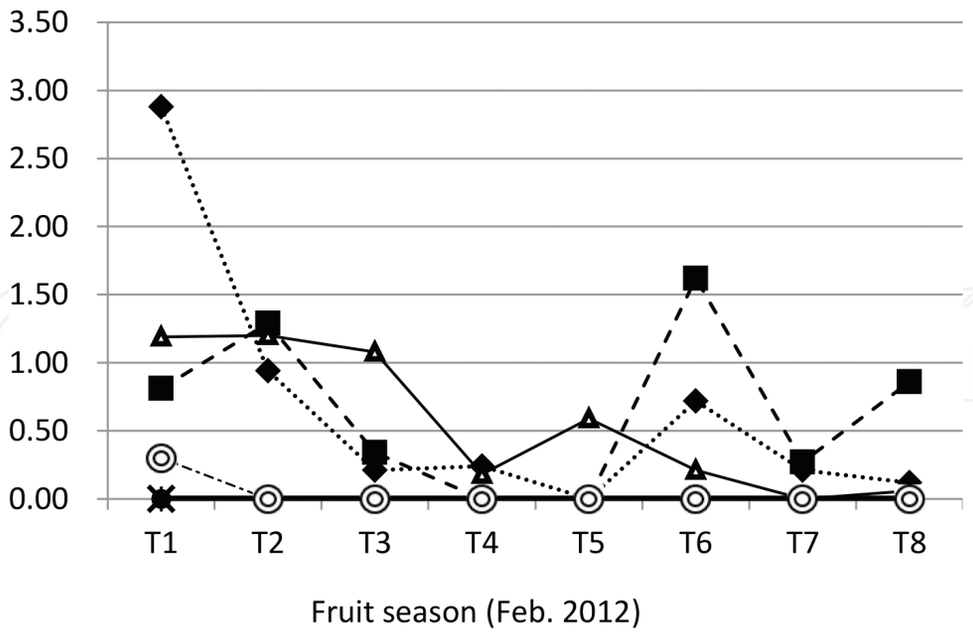
Note 2:*Significant level 10%;

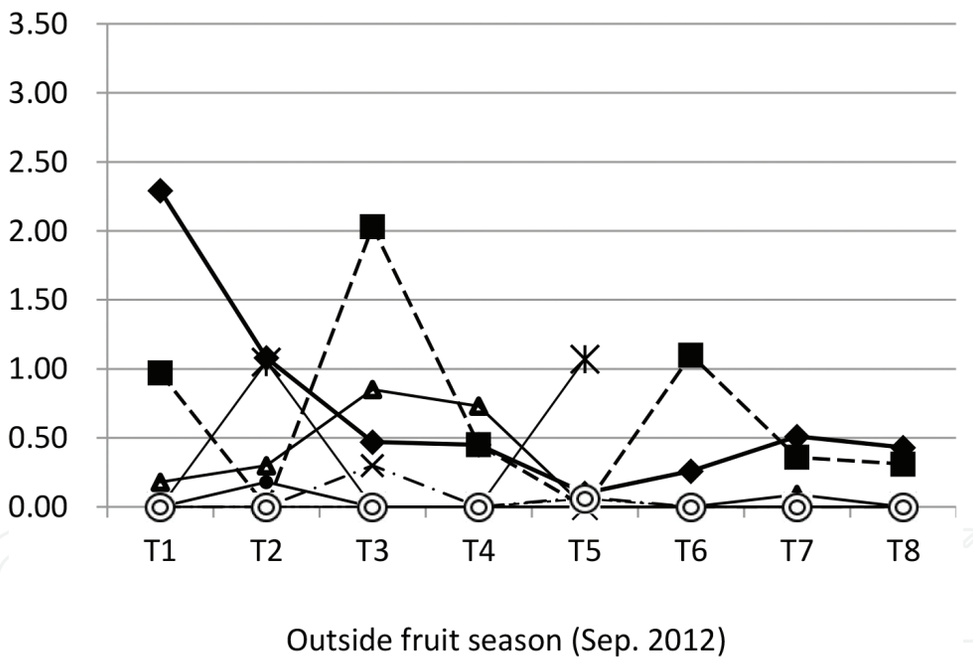
**Significant level 5%;

***Significant level 1%.

Note 3: Relative abundance = [numbers of observed cockatoo]/[length of a transect unit].

Table 7. Relative abundances of Moluccan cockatoos (number/1000 m).





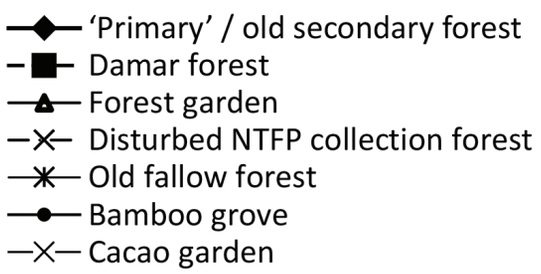


Figure 12. Relative abundances of Moluccan cockatoos in terms of forest type and time zone (number/1000 m). Source: Fieldwork. Note:T1, T2, T3, T4, T5, T6, T7 and T8 represent time zone 6:30–8:00, 8:00–9:00, 9:00–10:00, 10:00–11:00, 11:00–12:30, 14:30–16:00, 16:00–17:00, 17:00–18:00, respectively.

In the participatory transect surveys, I could not collect data after 18:00 (shortly before sunset) for a practical reason: the recorders were needed to prepare firewood for overnight camping. Therefore, cockatoo locations during the late evening are still unknown, but it can be presumed that the cockatoos' forest use patterns correspond to folk knowledge about parrot behaviors, as described earlier.

The data collected by the participatory transect surveys suggest that the cockatoos use primary and old secondary forests as shelters, roosting sites and feeding areas and that they frequently use HMFs as feeding sites (including damar forests, forest gardens and old fallow forest) during different time periods and seasons. Damar forests are used by the cockatoos all year, but the extent of their use of forest gardens tends to increase during the fruiting season.

4. Discussion

The locals under study have created and maintained diverse HMFs. Some of these are located inside the national park. The diverse HMFs enable the locals to enjoy a variety of forest provisioning ecosystem services. The HMFs appear to secure the livelihood of mountain people living in remote areas with poor access to local markets.

As indicated by the results of the cockatoo site surveys and the participatory transect surveys, among the various types of HMFs, NTFP collection forests, bamboo forests, cacao gardens and sago groves appear to be unsuitable habitats for the cockatoos, but less-intensively managed HMFs, such as damar forests and forest gardens, are suitable habitats.

If forest gardens and damar forests really contribute to providing important habitats for the cockatoo and if we attach great importance to the conservation of the cockatoo as part of national park management, it would be inappropriate to apply conventional national park management measures that strictly exclude any human intervention through agriculture (including arboriculture) inside the park.

In the northern coastal area of central Seram, there are coconut palm and cacao plantations as well as shrimp farms. In addition, transmigration programs and commercial logging have been conducted intensively since the 1990s [7]. These practices have caused forest degradation and deforestation in large areas of the lowland. An oil palm plantation company began operations in 2009.

Given that these large-scale development projects have destroyed and are destroying a large area of the forest, the park's importance in conserving regional biodiversity is undoubted. What I recommend here is more flexible park management measures that are consistent with local realities.

As long as locals engage in less-intensive and small-scale arboriculture, it is unlikely that their subsistence activities will negatively impact biodiversity in the park. Therefore, it would be desirable to establish special zones where locals can practice arboriculture in the park under certain conditions (e.g., limited to subsistence purposes).

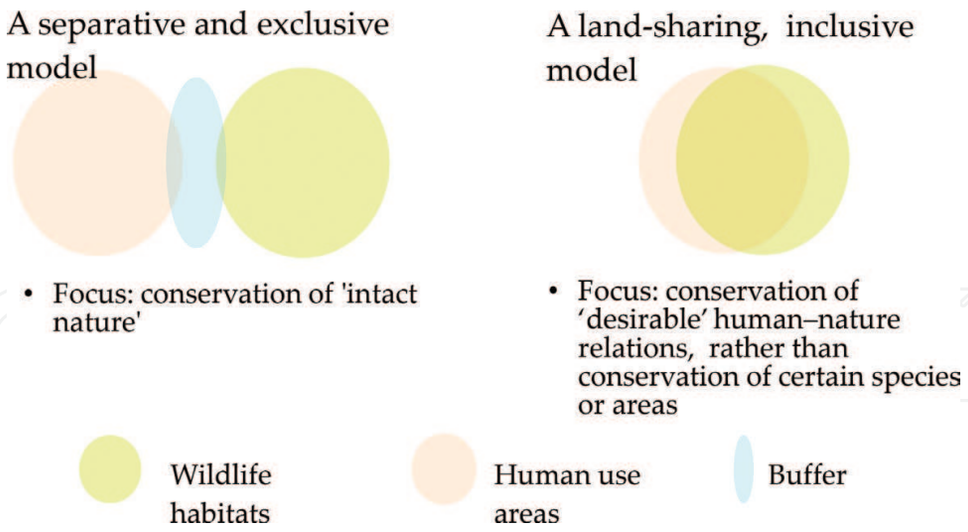


Figure 13. A new conservation paradigm versus the conventional paradigm.

To promote such a flexible system, a shift of management paradigm, away from the conventional separative model that strictly separates areas of human activity from conservation areas to a new one that focuses on human-wildlife relationships formed in human-modified landscapes (**Figure 13**) is necessary.

Space for less-intensively managed HMFs is diminishing through the process of "polarization of landscapes," where rural forest areas are divided into "development areas" used intensively for agricultural production and resource exploitation on the one hand and "conservation areas" for protecting "intact nature" on the other hand. We still know little about the roles of less-intensively managed HMFs in conserving flagship species and maintaining local biodiversity. Therefore, the conservation value of HMFs needs to be assessed.

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