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Editorial board

The *Journal of Indonesian Natural History* will be published biannually by the Department of Biology at the University of Andalas, Padang, Sumatra Barat, Indonesia, in collaboration with Copenhagen Zoo, Denmark. The Department of Biology at University of Andalas is dedicated to educating Indonesian biologists in the study and conservation of Indonesia's biodiversity and natural history. Copenhagen Zoo, through its Research and Conservation Division, supports in-situ conservation in Southeast Asia by assisting local organizations and individuals who undertake research, capacity building or the implementation of conservation programmes and projects.

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COVER PHOTO: Female green peafowl (*Pavo muticus*) foraging at the Bekol Savannah in Baluran National Park, East Java **(©** Carl Traeholt / Copenhagen Zoo).

Editorial

Carl Traeholt and Wilson Novarino, Editors

Indonesia is universally considered to be one of the World's most important biodiversity hot-spots (Mittermeier et al., 2005). With 670 species of mammal, 1604 birds, 787 reptiles and 392 amphibians species (IUCN, 2009), endless numbers of freshwater, terrestrial and marine invertebrates, plants and molluscs Indonesia's natural heritage is amongst the most exiting in the World. Spread over more than 18,307 islands, of which more than 8000 are inhabited, the Indonesian archipelago stretches more than 5000km from west to east and over three time-zones.

Indonesia's vast archipelago also encompasses one of the World's richest cultural diversities with more than 1000 ethnic cultures and 729 languages (AMAN, 2012; Lewis, 2009). Some of these date back thousands of years. One can say that Indonesia's history began approx. 1.8 million years ago when the "Java man" *Homo erectus soloensis* roamed Java's landscape (Brown, 1992; Indriati et al., 2011; Kaifu et al., 2008; Swisher et al., 1994). When Dutch archeologist Eugene Dubois excavated the first Java-man in 1891 it was, and continues to be, the oldest hominid discovered in Asia (Swisher et al., 2000).

In 2003 another member of the hominid family was discovered on Flores island (Brown et al., 2004; Morwood et al., 2004). This unearthed a pygmy sized hominid, *Homo floresiensis*, that appear to have coexisted with modern man until the end of the Pleistocene and the last glacial period 10-12.000 years ago (Argue et al., 2006; Lyras et al, 2009).

Indonesia has been the destination for thousands of explorers, adventurers, traders and researchers. Local merchants plied the archipelago as early as the 4th century at the beginning of the Tarumanegara, and merchant ships from China called upon ports in Indonesia a few centuries later. In a natural history context, perhaps none made a bigger impact than British naturalist Alfred Russel Wallace, who travelled the "Malay Archipelago" in 1854 to 1862 during which he collected more than 126.000 specimens, of which thousands were new to science. In 1869 Wallace published "*The Malay Archipelago*" describing his studies and experiences from the journey (Wallace, 1869).

When the modern nation of Indonesia was declared on the 17th of August, 1945, the concept of Bhinneka Tunggal Ika (unity in diversity) was inculcated in the Constitution as one of the key-pillars of the new nation. Indonesia's national emblem depicting Garuda Pancasila gripping a scroll with the national motto Bhinneka Tunggal Ika (Fig.1) is so popular that it can be found in all Government offices as well as many private residences, shopping centres and on a wide range of tourist artifacts.

Since Wallace's time the Indonesian natural history legacy continued to thrive with local and foreign researchers spending years studying,

Figure 1. The Indonesian coat of arms, Garuda Pancasila, gripping the scroll containing the national motto *Bhinneka Tunggal Ika*.

documenting and unraveling the country's rich cultural and biological diversity. The recent economic development has seen a significant increase in the average standard of living in Indonesia, often at a cost of losing biological diversity and important ecosystem services. Young generations of Indonesians are increasingly more interested in spending free time in shopping centers rather than in one of the nation's many magnificent national parks, and applying for jobs that guarantee air-conditioned working conditions. Yet, a large number of ecologists, anthropologists, botanists and conservation biologists at Indonesian as well as international universities and research institutions continue to study and document the nation's rich natural history. More importantly, these researchers continue to encourage, motivate and inspire the younger generations to engage in activities that ultimately will contribute to the safeguarding and long-term conservation of Indonesia's natural resources.

Figure 2. The launch of the Journal of Indonesian Natural History took place on the 12th of September, 2012, in commemoration of the 50th anniversary of the Department of Biology, University of Andalas, Padang. From left is Dr. Anthoni Agustien (Head of Dept. of Biology, Andalas University), editors Dr. Carl Traeholt (Copenhagen Zoo) and Dr. Wilson Novarino (Andalas University).

Despite the wealth of research and conservation activities taking place in Indonesia far too little of this is transformed into publications in local scientific journals that are made freely available to local resources personnel and interest groups. To continue to encourage and inspire future generations of natural history researchers it is essential that work by experienced researchers is made available to as many local students and resources people as possible. To encourage contributions from local researchers, manuscripts in Bahasa Indonesia and English will be accepted.

It also important that upcoming researchers have a chance to communicate their work to the established natural history community. Far too many MSc and/or PhD student projects end in obscurity despite addressing interesting and relevant contemporary research questions. Therefore, a section will be reserved specifically for short summaries of ongoing students' projects to communicate ideas, results and potential useful discoveries.

Starting up a new journal that is 100% perfect very difficult. Despite numerous proof-reading, reviews and extra reviews of content, typography and layout there are probably errors that we overlooked. Please exercise patience and understand that the making of this Journal is a process that will continue to improve with experience and with your feedback and help.

Finally, we would like to thank all our colleagues that have provided invaluable support to producing Issue 1, specifically to all members of the Editorial Board and to Copenhagen Zoo for providing the necessary funds to develop and sustain the Journal. With the launching of the Journal of Indonesian Natural History - or JINH - we hope to create a relevant journal that is consistently publishing quality papers and made available to a broad range of researchers, students and conservation practitioners (Fig.2).

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News and Notes

This section we will attempt to highlight some of the recent publications and books that are relevant to conservation and Indonesian natural history. In addition, we will bring write-ups from various relevant seminars, workshops and conferences that deal with biodiversity conservation and/or topics relevant to Indonesian natural history. For the latter, we welcome contributions from organizers and participants of respective events.

New publications

Maekawa, M., Lanjouw, A., Rutagarama, E. and D. Sharp (2013). Mountain gorilla tourism generating wealth and peace in post-conflict Rwanda. *Natural Resources Forum* **37(2)**: 127–137.

Mountain gorillas have been on the conservation radar for the past decades. They are a flagship species in Rwanda, but even with a declining population estimated at less than 900 individuals they seem begin to garner more conservation support, because they provide an important revenue to the local economy. This paper explores mountain gorilla conservation and nature-based tourism in Rwanda and discusses the challenges and key issues surrounding the conservation of this charismatic species.

Jorge, A., Vanak, A., Thaker, M., Begg, C. and R. Slotow (2013). Costs and benefits of the presence of leopards to the sport-hunting industry and local communities in Niassa National Reserve, Mozambique. *Conservation Biology* DOI: 10.1111/cobi.12082.

To hunt or not to hunt is a question that has been debated ferociously within the conservation community for the past three decades. This paper compares the relative economic gains from sport hunting and poaching of leopards (*Panthera pardus*) in Niassa National Reserve, Mozambique. The authors sent questionnaires to hunting concessionaires and local villagers. The results suggest that sport hunting generates larger gross revenues than poaching with each leopard having an estimated value of US$ 24,000 for a hunting concessionaire. However, illegal hunting provided higher economic benefits for the households involved in that activity. Unfortunately, most of the sport-hunting revenues were retained at national and international levels and, consequently, did not sufficiently compensate the local people for the economic losses they incur through loss of livestock. A poached leopard could be traded for as little as US$ 83, whereas leopards depredated 11 goats over 2 years in two of four surveyed villages resulting in losses of $440 to 6 households. Consequently, villagers in these areas had negative attitudes toward leopards. The authors suggest the economic benefits from leopard sport hunting should be used to provide community incentives e.g. contribution to improved livelihood in return for no poaching activities.

Ahlering, M. A., Maldonado, J.E., Eggert, L. S., Fleischer, R.C., Western, D. and J.L. Brown (2013). Conservation outside Protected Areas and the Effect of Human-Dominated Landscapes on Stress Hormones in Savannah Elephants. *Conservation Biology* **27 (3)**: 569–575.

Biodiversity is not confined to national parks and protected areas. Conservation strategies are increasingly focused on regions outside protected areas, where animals face numerous anthropogenic threats. The effects of animals living in human dominated areas can have profound implications for population viability. The authors used savannah elephants (*Loxodonta africana*) as a case study to assess the physiological stress associated with living in a human-livestock-dominated landscape. Fecal DNA was used to identify 96 individual elephants in a community conservation area and fecal glucocorticoid metabolite (FGM) concentrations was measured as a proxy for stress. Comparing FGM concentrations from community conservation areas to FGM concentrations of 40 elephants in Amboseli National Park and 32 elephants in the Maasai Mara National Reserve revealed no significant individual differences in FGM concentrations among the elephants in 2007 or 2008 and no difference between years. The elephants in the community conservation areas had similar FGM concentrations to the Maasai Mara population, but Amboseli elephants had significantly lower FGM concentrations than those in either Maasai Mara or the community conservation area. There authors found no clear evidence of chronic stress in elephants living on community conservation area suggesting that the elephants are able to adapt to variety of habitat conditions. This is encouraging for conservation strategies promoting the protection of animals living outside protected areas.

Foden, W.B., Butchart, S.H.M., Stuart, S.N., Vié J-C, Akçakaya, H.R. et al. (2013) Identifying the World's most climate change vulnerable species: A systematic trait-based assessment of all birds, amphibians and corals. *PLoS ONE* **8(6)**: e65427. doi:10.1371/journal.pone.0065427.

It is already well-known that the Earth is undergoing a significant period of climate change. The question is how will it impact biodiversity, including increasing extinction rates. Although many studies have taken tried to quantify impacts, but focus on measuring exposure to climatic change often ignore the biological differences between species that may significantly increase or reduce their vulnerability. The authors make an attempt to address this by assessing three dimensions of climate change vulnerability, namely sensitivity, exposure and adaptive capacity. This was applied to each of the world's birds, amphibians and corals (16,857 species). The assessments identify the species with greatest relative vulnerability to climate change and the geographic areas in which they are concentrated, including the Amazon basin for amphibians and birds, and the central Indo-west Pacific (Coral Triangle) for corals. The results revealed that 608–851 bird (6–9%), 670–933 amphibian (11–15%), and 47–73 coral species (6–9%) are both highly climate change vulnerable and already threatened with extinction on the IUCN Red List. Because fewer species appeared to be highly climate change vulnerable under lower IPCC SRES emissions scenarios, the authors suggest that reducing greenhouse emissions will reduce climate change driven extinctions too. The authors also suggest that by using independent assessment of the three dimensions of climate change vulnerability, their approach can be used to devise species and area-specific conservation interventions and indices.

Sunderlin, W.D., Larson, A.M., Duchelle, A.E., Resosudarmo, I.A.P, Huynh, T.B., Awono, A and T. Dokken (2013). How are REDD+ Proponents Addressing Tenure Problems? Evidence from Brazil, Cameroon, Tanzania, Indonesia, and Vietnam. *World Development,* http://dx.doi.org/10.1016/j.worlddev.2013.01.013

While REDD+ may offer a mechanism for many nations to transform their energy dependence from fossil fuel to "greener" alternatives the impact on communities are not well understood. The authors address tenure insecurity in light of actions required for effective and equitable implementation of REDD+. Field research was carried out at 19 REDD+ project sites and 71 villages in Brazil, Cameroon, Tanzania, Indonesia, and Vietnam. Although results revealed proponents addressed tenure insecurity by demarcating village and forest boundaries as well as identifying legal right holders, there were obvious limitations when it came to resolving local tenure challenges that were national in origin and scope. The authors suggest that national tenure actions, integration of national and local tenure efforts, clarification of international and national REDD+ policies, and conflict resolution mechanisms are needed to further the REDD+ concept in the project areas studied.

Trinajstic, K., Sanchez, S., Dupret, V. et al (2013). Fossil Musculature of the Most Primitive Jawed Vertebrates. *Science* DOI: 10.1126/science.1237275.

The transition from jaw less to jawed vertebrates (*Gnathostomas*) resulted in the reconfiguration of the muscles and skeleton of the head, including the creation of a separate shoulder girdle with distinct neck muscles. The authors describe the only known examples of preserved musculature from placoderms (extinct armored fishes), the phylogenetically most basal jawed vertebrates. The study suggests that neck musculature evolved together with a dermal joint between skull and shoulder girdle, not as part of a broadly flexible neck as in sharks, and that transverse abdominal muscles are an innovation of gnathostomes rather than of tetrapods.

Willemen, L., Drakou, E., Dunbar, M., Mayaux, P. and Egoh, B. (2013) Safeguarding ecosystem services and livelihoods: Understanding the impact of conservation strategies on benefit flows to society. *Ecosystem Services* **4**: 95-103.

This paper explores how biodiversity conservation influences the flow of ecosystem services to various members of society. Particular focus is given to the members of society whose livelihoods are often more dependent on ecosystem services. Five ecosystem services were mapped in the Democratic Republic of Congo and their direct beneficiaries identified. The evidence collated was then used to feed a discussion on the impact of different conservation strategies on society at the 4th Ecosystem Service Partnership Conference in the Netherlands. The discussion highlighted the need for an assessment of ecosystem service trade-offs, as well as the main challenges for conservation measures to contribute to both livelihood improvement and conservation gains. The paper argues that ecosystem services maps can play a crucial role in understanding and managing the trade-offs in ecosystem service flows resulting from conservation strategies.

Matsuda, I., Higashi, S., Otani, Y., Tuuga, A., Bernard, H. and R.T. Corlett (2013). A short note on seed dispersal by colobines: The case of the proboscis monkey. *Integrative Zoology*. DOI: 10.1111/1749-4877.12033 (*in press*)

Although primates in general are considered important seed dispersers colobines, a widely distributed primate subfamily in Asian and African tropical forests, are less studied. They consume leaves, seeds and fruits. This study focused on a group of proboscis monkeys (Colobinae, *Nasalis larvatus*) consisting of an alpha-male, six adult females, and several immatures that was observed for 13 months. In this period the authors collected 400 fecal samples that were later examined and recorded 3,500 hr of focal observation data on the group members in a forest along the Menanggul River, Sabah, Malaysia. Intact small seeds were found in 23 of 71 samples in November 2005, 15 of 38 in December 2005, and 5 of 21 in March 2006. Seed occurrence seemed to be seasonally determined and the findings are possibly the first records of seeds in the fecal samples of colobines. The authors suggest that even if colobines pass relatively few seeds intact, their high abundance and biomass could make them quantitatively significant in seed dispersal.

Events

ATBC Asia Chapter Meeting, Aceh

The Association for Tropical Biology and Conservation's "Asia Chapter" held its 6th annual meeting in Banda Aceh, Sumatra, from the 18-22nd of March, 2013. More than 200 participants from 25 countries listened to a large number of presentations, key-note speakers and engaged in discussions and debates after each plenary. In the best of Indonesian tradition Hermes Palace Hotel provided excellent service and made sure nobody went to bed hungry.

A number of new people volunteered for the positions as Country Representatives for Asia Pacific Chapter, each of whom received nominations from other ATBC members.

China - Bosco Chan
Lao PDR - Manichanh Satdichanh
Malaysia - Catherine Yule
Myanmar - Nay Myo Shwe
South Pacific - Pierre-Michel Forget
Vietnam - Truong Vuong Ba

Although the ATBC began publishing a conservation related declaration in 2005 the Asia Chapter has never done it in the past. Considering the serious threat to the Sumatran natural habitat, particularly the in Aceh province that contains the largest block of remaining intact forest on Sumatra, the committee decided to produce a declaration.

The Banda Aceh Declaration

The Crucial Importance of Aceh's Forests

WHEREAS, the Aceh people through their unique culture, such as the Mukim and Panglima Uteun customary bodies, have preserved the forests of Aceh, Sumatra, through the centuries for their welfare, well-being and future generations; and

WHEREAS, the Aceh forests are essential for food security, regulating water flows in both the monsoon and drought seasons to irrigate rice fields and other cash crops; and

WHEREAS, forest disruption in Aceh's upland areas will increase the risk of destructive flooding for people living downstream in the coastal lowlands; and

WHEREAS, the special autonomy enjoyed by Aceh in Indonesia provides a unique opportunity for the province to develop innovative spatial planning to show that economic development and sound environmental management are fully compatible; and

WHEREAS, Aceh's forests, such as in the UNESCO World Heritage Site of Leuser, are internationally renowned for being the only place on Earth where elephants, tigers, rhinoceros and orangutans all co-occur; and

WHEREAS, further conversion of lowland forest will increase conflicts between people and surviving wild elephants, posing a significant threat to farming livelihoods; and

WHEREAS, components of the current Spatial Plan in Aceh, especially certain forest developments and new infrastructure projects, will elevate the risk of serious local environmental problems, a loss of key nature hydrological functions, and serious disruption of lowland river systems and fisheries, which could negatively affect human livelihoods and biodiversity.

THEREFORE, be it declared that the Asian Chapter of the Association for Tropical Biology and Conservation (ATBC), the world's largest scientific organization devoted to the study, protection, and wise use of tropical ecosystems:

RECOMMENDS that the Spatial Plan for Aceh be based on the extensive, high-quality spatial data that are available within the Government of Aceh agencies, especially maps on watershed forest areas, environmental risk, soil types, geological hazards, human population centres, rainfall and the distribution of Aceh's wildlife; and

RECOMMENDS that the Government of Aceh collaborate with national and international scientists to identify environmentally sound alternatives for road infrastructure that meet local development aspirations without irreparably damaging the integrity of Aceh's natural environment; and,

SUGGESTS that the most appropriate economic development model for Aceh is one that prioritizes clean development and payments for environmental services, while limiting unsustainable natural resource extraction; and

APPEALS TO the Government of Aceh to ensure that the rule of law is immediately upheld, to halt ongoing illegal logging, forest conversion and road building and to ensure that developments within its forest estate are based on sound forest-management principles.

Sumatran Rhino Crisis Summit

Widely recognized as one of the World's most imperiled mammal species the Sumatran rhino is on the brink of extinction. As a last ditch effort to save the species Singapore Zoo hosted the Sumatran Rhino Crisis Summit intended to once and for all lay out an effective conservation plan. On April 1-4th, 2013, many of the World's leading rhino experts, representing Government authorities, Universities, NGOs and private organizations convened at Singapore Zoo's Forest Lodge and participated in panel discussions, "Open Space Technology" and group discussions. The approximately 110 participants agreed that urgency is needed to prevent the species from going extinct. A major output of the event was the agreement between the Malaysian and Indonesian Government representatives to view Sumatran rhino populations as one meta-population, and to allow for transfers of specimens and/or samples between the two countries. Time will tell if the positive statements will transform into effective conservation action on the ground.

Baluran International Birding Competition

The 4th Annual Birding Competition was held in Baluran National Park from 26-30th of June, 2013. Baluran National Park is known for its diversity of almost 200 different bird species. Baluran - declared a national park on March 6th, 1980 - held its first birding competition in 2010.

The 4th installment of the event attracted 65 teams that competed in the categories of bird watching, article writing and photography for the largest prices to date. The total price money for this year's event exceeded 80 million Indonesian Rupiah (~ US$ 7,700).

Category: Photography
1st price (bird) – Mona Amellia Pirih (Surabaya)
2nd price (bird) – Rendra Des Kurnia (Banyuwangi)
3rd price (bird) – Riky Cahyo Sutrisno (Banyuwangi)
Animal (non bird) – Irwan Yuniatmoko (Jogjakarta)
Flora – Agung Satriya Wibowo (Jogjakarta)
Landscape – Bayu Catur Pamungkas (Banyuwangi)

Category: Bird watching and article writing
1st price – "Bionic Uchira Konohabinangun Sembada" (Jogjakarta)
2nd price – "Bionic Better Right Hand" (Jogjakarta)
3rd price – "Bionic Bakpia Pathuk" (Jogjakarta)
Favorite story – "Kutu Air I" (Jakarta)

Automatic data organization, storage, and analysis of camera trap pictures

Jim Sanderson[1,2] and **Grant Harris**[3]

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Abstrak

Sistem jaringan kamera otomatis mampu menghasilkan ribuan gambar dalam waktu yang singkat. Sebagai contoh, 35 kamera di Sevilleta National Wildlife Refuge di new Mexico, Amerika Serikat telah memproduksi lebih dari 1.9 juta gambar sejak Juni 2009. Program Pemantauan oleh US Fish and Wildlife menghasilkan kira-kira 30.000 gambar per minggu. Meskipun pengambilan dan penyimpanan gambar adalah hal yang dianggap tidak begitu penting, pengisian dan analisa data menyita waktu yang banyak serta rentan mengalami kesalahan. Hal ini terutama pada saat pengisian data kedalam lembaran data dengan pengetikan tangan menggunakan keyboard. Tujuan kita dalam hal ini adalah untuk meningkatkan kecepatan pengisian data dengan meminimalkan kesalahannya, lebih mudah melakukan analisa, serta memungkinkan data dari berbagai lokasi dapat terhubung dan dianalisa dalam satu rangkaian data. Tujuan tersebut dapat dicapai dengan mengeliminasi entri data dengan tangan menggunakan keyboard, dan lebih mengarahkan pengguna untuk berinteraksi dengan file data gambar melalui penggunaan perangkat open software. Pengecekan kesalahan juga secara otomatis. Tulisan ini memperbaharui metodologi yang dijelaskan dalam Harris et al. (2010) dengan menyediakan langkah-langkah panduan penyimpanan data perangkap kamera dan analisa, tanpa melakukan entri data dengan keyboard. Metodologi ini sudah digunakan dan memberikan telah memberikan keuntungan bai komunitas penggunanya. Program ini tersedia secara gratis di http://www.smallcats.org/CTA-executables.html.

Abstract

Networks of automatic cameras are producing many thousands of images over modest time periods. For example, 35 cameras at Sevilleta National Wildlife Refuge in New Mexico, USA have produced more than 1.9m useful images since June, 2009. A US Fish and Wildlife monitoring program is producing about 30,000 images per week. Although image file retrieval and storage is trivial, data entry and analysis are both time consuming and error prone since data is most often entered by hand from a keyboard into a spreadsheet. Our objectives were to increase data entry speed while minimizing data entry errors, easily run data analysis, and enable data from multiple locations to be concatenated and analyzed as a single data set. These objectives are achieved by eliminating the task of hand data entry via a keyboard, and managing user interactions with image file data through the use of a suite of open software tools. Error-checking is also automatic. Here we update the methodology described in Harris et al. (2010) by providing a step-by step guide for automatic camera trap data storage and analysis without entering data by hand from a keyboard. This methodology is already in use and is benefiting from an established user community. The programs are available free on http://www.smallcats.org/CTA-executables.html.

Key words: Automatic data organization; analysis; camera trap

Introduction

The use of automatic cameras to monitor wildlife has increased dramatically globally. The greater community of users recognizes the need for a common, simply way to organize, store, analyze, and share data from camera traps. Most users realize that data entry by hand from a keyboard is both cumbersome and error prone (Maydanchik, 2007). Moreover, once data is entered into a spreadsheet, data manipulation is done mostly by hand. Harris et al. (2010) offered a methodology to overcome many of the issues faced by users of automatic cameras. The methodology is intuitive and does not require data entry by hand from a keyboard.

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Each step from data organization to data analysis and sharing is facilitated by powerful software available free on the internet. Numerous advantages occur when using a standardized methodology, not the least of which is that data from multiple sites can be analyzed as a single data set. Moreover, intermediate files that are produced automatically can be loaded error-free into spreadsheets.

The methodology described in Harris et al. (2010), having been adopted by many users, has since been improved and streamlined. What follows is a step-by-step end-to-end description of the methodology that by its very nature recognizes that camera data collection and analysis is iterative and ongoing. No attempt is made to replicate other camera analysis software tools.

Methods

Introduction

Data relabeling and storage is a two-step process. First, all images are labeled with their date and time simultaneously and automatically. Second, images are sorted into location/species/number-of-individual folders. Once this step is completed data analysis is set up by running program DataOrganize, adding the UTM and elevation information to each camera location, and then running program DataAnalyze. Since the methodology is iterative, an inexperienced user can go through the entire procedure with a few images taken from several camera locations. Before the first step can be done, preliminary groundwork is needed once and only once.

Data retrieval and relabeling

First, a summary of the camera trap data retrieval, relabeling, identifying and counting, and then storing the images is given. Following the summary, each step is detailed. Also described is a program that relabels jpg-files that have been incorrectly dated.

Groundwork details

First create a top-level folder here called

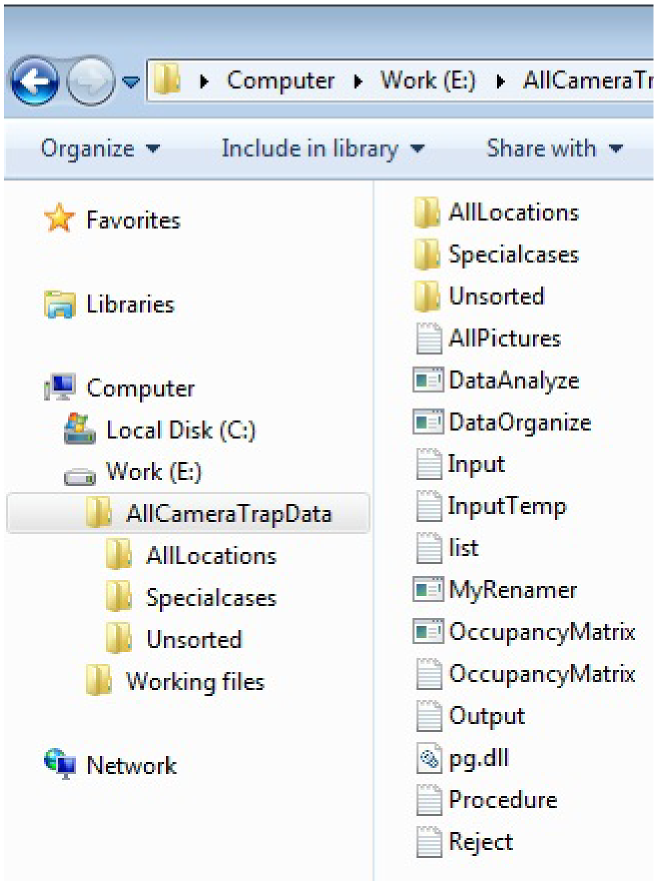

Figure 1. The folder here called AllCameraTrapData contains three folders: AllLocations, SpecialCases, and Unsorted. All programs and files are downloaded sand saved in folder AllCameraTrapData.

AllCameraTrapData that will contain all the programs, How_to text files, PowerPoint presentation, published paper by Harris et al. (2010), and three folders: AllLocations, SpecialCases, and Unsorted. Open http://www.smallcats.org/CTA-executables.html and download and save all the files into folder AllCameraTrapData. Folder AllLocations (any name can be used so long as it is one word without embedded blanks) will contain all the camera trap images. Folder SpecialCases (again any name will suffice so long as it is one word without embedded blanks) will contain all images whose date and time are not correct. Folder Unsorted (or whatever name is used) will contain all unsorted relabeled images organized by location and date (Fig.1). Alternatively, folder "Unsorted" can be placed in each location folder.

I. Create a hierarchal folder structure to hold the images

The following file structure is needed within the AllLocations folder (Fig. 2). Each image will ultimately be stored in AllLocations/Location/Species/# folder. Note that a template location folder containing species/# folders can be copied, pasted, and relabeled with the new location. Folders can also be created when needed such as during the drag-and-drop procedure described below.

(1) Site refers to the general area where the camera traps are running. Site is the top-level main directory where all files are stored. This might be Gunung Kerinci, Komodo, or AllCameraTrapData (used here). This folder contains all the programs, How_to text files, and all other files necessary for camera trap data analysis (Fig. 1).

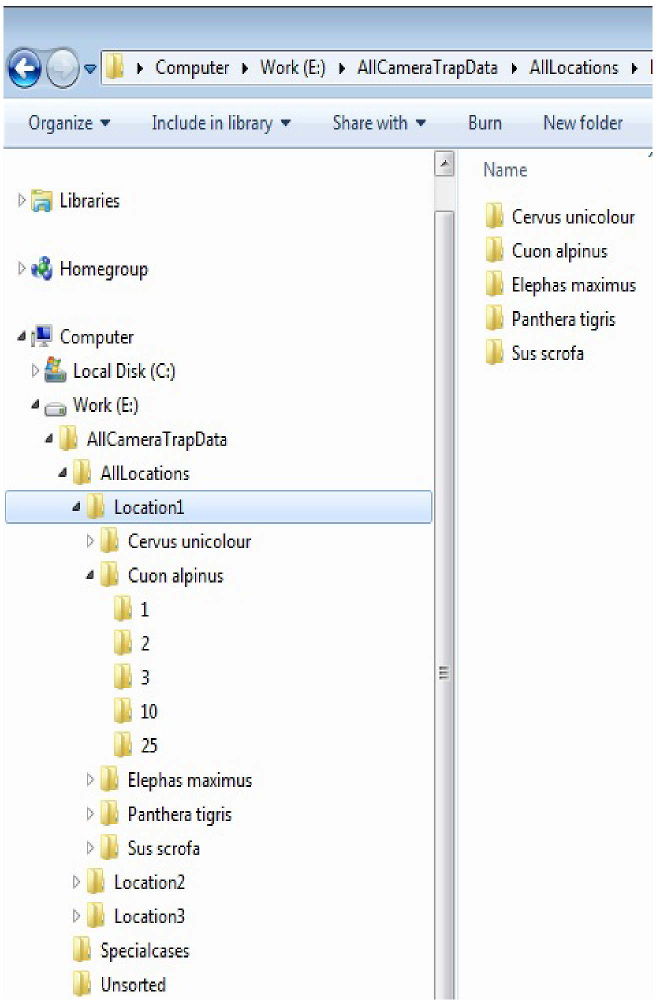

Figure 2. An example of a hierarchal folder camera trap data structure. Note that the folder structure within AllLocations is three and only three levels deep.

(2) Location is a place where a camera trap is set. Locations might be Loc01, Loc02, or have names like Sg. Young, Bekol, or Bukit Lawang. Make sure no two locations have the same name. Location names are limited to 25 characters (Fig. 2).

(3) Species folders are folders of species names in each location folder. These might be Tiger, elephant, and Domestic dog. Species names are limited to 25 characters, and it is recommended that Latin names are used for consistency.

(4) Number (#) are folders in each species folder labeled with the number-of-individuals in the image: 01, 02, …, 99. Note that a species folder labeled "Unknown" has a number-of-individuals folder 01. Without exception, all jpg files reside in number-of-individuals folders. Not all 01-99 are necessary. It does not matter if some are empty or are not present. It is likely that for most species there will be only a single folder (namely 01) (Fig. 2).

(5) In addition to actual species, folders can represent multiple species such as Birds, Amphibian, or Skunks that represent several skunk species that can be later identified by an expert. Other typical folders are "Ghost" where waving grass triggered an image, or "Unknown" such as an image taken at night that contains an animal that cannot be identified, Human, and Vehicle. These are typically not included in data analysis. The "AllLocations" folder can have any name so long as it is one word with no embedded blanks (Fig. 2).

II. Visit a camera trap, remove the memory card, and store the images in a temporary folder here called Unsorted.

Storing all the images from a memory card in a temporary location folder here called "Unsorted" and then relabeling them in step III prevents subsequent loss of image files. Image file counting resets to zero when images are removed from the memory card. Subsequent file moves can over-write existing files. Relabeling the image files with their date and time makes the image files unique and prevents files from being over-written.

IIIa. Digital images. Relabel all the files in the temporary folder simultaneously with the date and time the image was recorded.
The freeware program "ReNamer" is used to simultaneously relabel all images in the temporary location folder. ReNamer is downloaded from: http://www.snapfiles.com/downloads/denrenamer/dldenrenamer.html.

Follow the download instructions and create a short-cut on your desktop. Then,

(1) Open ReNamer by double clicking on the icon.
(2) Click on Settings, then Meta Tags.
(3) Remove the punctuation in the date so that a single blank space separates each field. The date and time should look like:

yyyy mm dd hr mn sc

Then click on the save button.

(4) Drop and drag a file, group of files, or a folder into the lower frame of ReNamer. The files are listed.

(5) Click + Add to add the first rule. Select "Delete". Then in the "Until box" click on the button "Till the end". The button "Skip extension" has already been selected. This rule deletes the name of each jpg file, but gives an error that there are multiple files with the same blank name. Ignore the error. Click on + Add Rule to add the rule.

(6) Click +Add to add the second rule. Select Insert, then click the yellow lightening bolt Insert Meta Tag, and select from the drop-down list EXIF_Date. Then click the green check Insert. Click +Add Rule.

(7) Click on Preview on the upper right of the ReNamer box and the new names should appear. If the file label does not appear as yyyy mm dd hr mn sc.jpg then chances are the camera trap does not keep track of seconds so that two files have the same name but were taken in different seconds. To create a unique label the user can add five seconds to the time. If many files are unlabeled program SpecialRenamer automatically adds five seconds to create a unique label. To the right of "Preview" click on the green "Rename" right arrow and the files are relabeled and saved (Fig. 3).

(8) From the top menu list select "Presets", save as, and then give your rules a name like "EXIF_Date_Time". You can then use the rules again without re-entering them simply by loading from Presets.

(9) We recommend creating three Preset rules, because some camera trap manufactures do not store the date and time in the EXIF_date meta tag. In (6) present rule EXIF_Date_Time was created. Create two more preset rules using step (5) and then in (6) chose from MetaTags File_DateModified. Store this as Preset File_DateModified. Next create another Preset called File_DateCreated by choosing in step (5) File_DateCreated from the MetaTags menu.

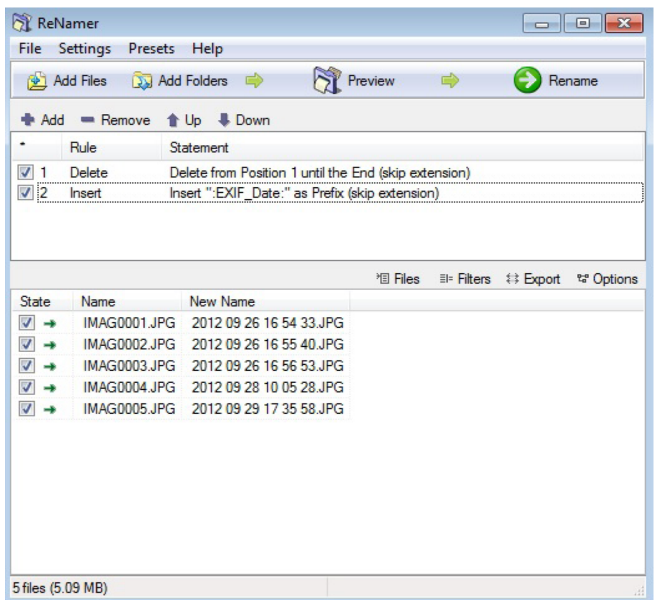

Figure 3. A screen-shot of ReNamer after selected pictures have been renamed according to yyyy mm dd hr mn sc.jpg.

(10) Each of the three Preset Rules contains two rules. The first rule deletes the current label, and the second inserts the EXIF_date & time, FileDateModified, or File_DateCreated – whichever works for the camera traps. Check that the date and time label matches the date and time shown on the image. If the label does not match the date and time on the image, apply a different Preset Rule. Note that only the file label is altered. The image metadata is not altered.

IIIb. Film images. Relabel all the files in the temporary folder by hand with the date and time the image was recorded.

Unfortunately for film images this step must be done manually since the year and month are inferred and the day and time are imprinted on the image. The subsequent steps are the same.

IV. For each image file, identify the species, count the number of individuals of each species recorded, and darg-and-drop the file into the proper location/species/nuber-of-individuals folder (Fig.2).

In Windows use Explorer to open the folder AllCameraTrapData and display the location, species, number-of-individuals folders on the left (if you prefer to drag left) or right side (if you prefer to drag right) on the screen (Fig. 2). Open the Unsorted/location-date folder that contains the images that have been relabeled with their date and time but have yet been sorted. Opening an image is unnecessary if extra-large icons are displayed. Drag-and-drop the image into the appropriate species/number-of-individuals folder. In the event that two or more species are recorded, store a copy of each species in the proper species/number-of-individuals folder. For example, suppose the first image at Location 01 contains 10 Sambar deer. This image is dragged-and-dropped into Location 01 folder, species folder Sambar deer, number-of-individuals folder 10. About 500 images per hour can be sorted. This procedure is repeated for all subsequent images stored in Unsorted/Location 01. All camera locations are treated the same way each time the SD card is removed.

V. Return to step II above until all camera traps have been visited and images processed. Note that at no time was data enter data by hand.

Data creation and analysis

There are two steps: (1) data creation and (2) data analysis. Both are done with software.

I. Creation of AllPictures.txt and InputTemp.txt

Data creation is necessarily an iterative step since DataOrganize terminates on each error it finds, but attempts to show where the error occurred. Two files are used to find relabeling or storage errors: AllFoldersFiles.txt and AllInfo.txt. If DataOrganize terminates normally these two files do not appear.

By this step all camera trap images have been relabeled with their date and time and stored in the Location/Species/Number-of-Individuals folders. Folder AllLocations (or whatever you called this folder) has all the location folders.

Double-click on DataOrganize, enter the name of the AllLocations folder making sure that the spelling matches the folder name exactly. Allow the program to run to completion which might take some time since the files must all be sorted chronologically within each folder.

If the program ends with the message *press enter to terminate normally* congratulations. AllPictures.txt and InputTemp.txt have been created and added automatically to your folder. Sometimes, there will have been an error in the way images were relabeled or stored causing DataOrganize to abort prematurely. If DataOrganize does not terminate normally, with 100% certainty there is an error someplace. Open AllInfo.txt and use it to track down and repair the error that can be pinpointed in AllFoldersFiles.txt. AllFoldersFiles.txt is complex but systematic list of what is in folder AllLocations. DataOrganize is infallible. After repairing the error, double-click on DataOrganize again and repeat this procedure.

Repeat this step until all errors are corrected and the message *press enter to terminate normally* appears. Only AllPictures.txt and InputTemp.txt appear. AllInfo.txt and AllFoldersFiles. txt are automatically deleted.

AllPictures.txt is a simple text file listing of all that is known of each camera trap image ordered first by location, then species, date, time, and number of individuals. Each line appears as:

Location 01 Sambar deer 2012 10 10 12 51 35 10

Text file AllPictures.txt has three roles. First, since each line is space delimited AllPictures.txt can be loaded into any spreadsheet program such as Excel. Second, AllPictures.txt is easily e-mailed. Third, AllPictures.txt from other sites can be easily concatenated and analyzed together as a single camera trap effort.

Text file InputTemp.txt is also produced. InputTemp.txt is a list of all camera locations, their start and stop dates, and has place holders to enter the UTM location and elevation. InputTemp.txt also has a list of all species including Ghost, Unknown, Human, Vehicle, and other species that might not be included in the analysis step. InputTemp.txt is edited and saved as Input.txt for use in the data analysis step. Input.txt serves three purposes. First, it contains UTM and elevation information for the camera location. Second, it is used to control what camera data is analyzed. Third, it can be easily e-mailed.

InputTemp.txt looks like this. Comments are in [*].

CAMERA TRAP DATA FROM XXXX [single line information header edited by user]
2 UTME-W UTMN-S ELEV [2 is the number of camera locations].
Arroyo Seco 000000 000000 000 [first location and space holder for UTM and elevation].
1 [1 is the number of start-stop dates that is accepted or edited by user].
2005 8 1 2008 10 14 [sequential list of start-stop dates of camera].

Gundagai 000000 000000 000
1
2005 8 5 2008 11 17
8 [number of species taken from all location folders]
Elephant [list of species in alphabetical order]
Ghost
Human
Peacock
Sparrow
Unknown
Vehicle
Zebra

2. Editing InputTemp.txt to create Input.txt

Here we have changed the header to be more informative, entered the UTM and elevation, changed the number of start-stop dates for each camera, and edited the species list to contain only the species we want to analyze. Note that the number of start-stop dates changed from 1 to 6 for the first camera and 1 to 5 for the second camera. Note also that only the first list species will be analyzed; in this case two mammals will be analyzed. The list can be switched and birds will be analyzed next. Species Ghost, Human, Unknown, and Vehicle will not be included in the analysis. InputTemp.txt is then saved as Input.txt.

SUMATRA CAMERA TRAP DATA
2 UTME-W UTMN-S ELEV
Arroyo Seco 524907 511503 316
6
2005 8 1 2005 8 1
2005 9 14 2005 9 30
2006 1 16 2006 5 31
2006 7 7 2007 8 12
2007 9 23 2007 10 10
2007 11 29 2008 10 14
2005 8 1 2008 10 14
Gundagai 523778 507548 285
5
2005 7 5 2005 11 8
2006 1 2 2006 1 15
2006 2 17 2006 5 6
2006 6 22 2006 7 29
2006 12 23 2008 11 17
2
Elephant
Zebra
2

Peafowl
Sparrow

Data analysis

Data analysis uses AllPictures.txt and Input.txt. Double-click on DataAnalyze. File Output.txt contains the full analysis of your data.

Additional features: correcting corrupted jpg-files

Program MyRenamer is used to correct corrupted jpg files. Typically MyRenamer is used when a camera trap's date and/or time have not been properly initialized. Store all the jpg files that need correcting in a folder here called SpecialCases in folder AllCameraTrapData folder where all the programs are located. Double-click on MyRenamer. The program asks for the folder where the jpg files are stored. Type SpecialCases (or whatever you called it), then Enter.

The program asks for the offset. The offset is 6 integers each of which is>= 0 and each separated by a space. The offset is added to the date and time to correct them. Note that carry-forward happens. Thus, if 7 months are added to a jpg file that shows 9 months, then the result will be that the final correct month is 04 and one year will be added to the year automatically. That is, just as is the case with the camera: a certain number of years, months, days, hours, minutes, and seconds are behind, and this "constant offset" is true for every image. Note that if an error has been made in the offset then the offset can be corrected and MyRenamer run again. The second, or corrected offset, is not a correction to the first offset but rather the actual jpg file as it came from the camera trap. The date the jpg file was taken according to the camera trap can be seen in the outMyRenamer.txt file.

Sequential or burst images with the same date and time can be relabeled properly using MyRenamer. If the offset is 0 0 0 0 0 0 then MyRenamer will read the date and time from the image metadata, and add 5 seconds until each image is uniquely labeled with its date and time + some multiple of 5 seconds.

Preserving changes in Input.txt when more data is added

Program UpdateInput is used to create a new Input.txt file from an old Input.txt file so that you do not have to retype the UTMs, elevations, and alter start times each time more data is stored. First rename Input.txt as InputOld.txt. Double click on DataOrganize to produce new AllPitcures.txt and InputTemp.txt files.

Double-click on UpdateInput. This produces InputNew.txt that preserves the first line, all UTM and elevation information, and start dates you may have changed. Note that the species list is not preserved since it is replaced when new images are included. New stop times and new locations are added by DataOrganize. You must now edit InputTemp.txt to produce Input.txt that will be used in the analysis.

Creating multiple start-stop times

Program CorrectInput uses AllPictures.txt and Input.txt to create a new list of start-stop times for each camera trap location. At each location, consecutive images separated by more than 29 days are assumed to have resulted from a dead camera trap. This dead-time gives rise to multiple start-stop times. File DateList.txt contains the list of start-stop dates that can be substituted into InputTemp.txt.

Spreadsheet camera trap data

Much camera trap data is presently stored in spreadsheets. In this case, the spreadsheet functions can be used to produce the AllPictures.txt that contains a list of images in the form (*) above. Since no protocols for storing camera trap data exist, it is not possible to give a typical example of how to produce (*) above from existing spreadsheet data. However, we have not yet found an example of spreadsheet data that cannot be converted and stored in text form identical to (*) above that is required by the analysis program software. Presuming AllPictures.txt has been created InputTemp.txt is easily created by double-clicking program CreateInput.

Analyzing multiple sites

Multiple sites can be analyzed by concatenating AllPictures.txt from each site. Double-click CreateInput to create InputTemp.txt. Edit InputTemp.txt and save as Input.txt. Double-click DataAnalyze to produce a full analysis of all sites.

Creating occupancy matrices for programme presence

Every user knows that creating matrices for program PRESENCE to estimate occupancy is difficult and fraught with errors. Moreover experimenting with the number of so-called camera trap occasion days is difficult. Program MatrixOccupancy removes these difficulties and is error-free. MatrixOccupancy uses AllPictures.txt to produce matrices for program PRESENCE using the number of camera trap days specified by the user. Periods where a camera is not operated appear as a "-", an absence is "0", and a presence is "1" as is required by program PRESENCE. The text matrix is simply copied and pasted into program PRESENCE. Simply double-click MatrixOccupancy and the enter the number of days in a camera trap occasion.

Discussion

Many millions of camera trap pictures have been taken from diverse locations around the world. Unfortunately far fewer have been analyzed. The vast majority of camera trap pictures remain simply pictures, disconnected and possibly endangered records existing on a computer hard drive somewhere. These camera trap pictures, some dating back 30 years, would be extremely valuable if they were all relabeled with their date and time, sorted, and stored. Mining this veritable mountain of camera trap data would become possible, and results collected today could be compared with results collected in the past.

We believe that camera trap pictures are the equivalent of museum specimens; both require curating. The methodology we described aids curating camera trap pictures, and we believe that whether our methodology for relabeling and sorting pictures is used or not, using a standardize method is better than using no method. Migrating from one relabeling and sorting procedure to another can be facilitated with software but waiting to adopt the latest methodology is like waiting to purchase a new more powerful computer – it is easier to upgrade than to start from the beginning.

Users enjoy the power of community. We have had discussion with camera trap manufacturers about labeling pictures with the date and time the picture is recorded on the memory card. When enough users of our methodology make the same demand perhaps the manufacturers will answer our requests. Users of our methodology agree that entering data by hand at a keyboard is now a thing of the past and recently we added the option of "drag-and-drop sorting step" sorting by voice commands. The user's voice is transmitted to the computer program that interprets the voice command, and executes it. For example, if a picture of two elephants appears on the screen the user speaks "elephant". If no elephant folder exists, one is created in the proper location folder. The question "How many?" appears on the screen. "Two" the user answers, and the picture is automatically moved to the Elephant/02 folder and the next picture appears automatically without touching the keyboard or mouse.

However, one step still requires a human: identifying the species and counting the number of individuals in a picture. No computer program exists to do this. Even when the list of species at a location is small, say on the order of 10, no program exists to identify the species and count the number of individuals. Pattern recognition remains a difficult problem that goes far beyond identifying animals in pictures. Perhaps the growing user community will encourage others to solve this outstanding problem.

The growing user base means that more useful programs will be written. Now available on http://www.smallcats.org/CTA-executables is a new program called GroupLocations. Program GroupLocations uses AllPictures.txt, Input.txt (both generated by program DataOrganize) and a user provided text file GroupMap.txt. For instance, imagine a camera trap study of 5 mountain ranges, each with some number of cameras. We wish to analyze and present the analysis of all the data by mountain range rather than by camera trap location as program DataAnalyze does. GroupMap.txt lists all the camera locations and the "group" that each is mapped into. Double-clicking GroupLocations creates a full analysis of each mountain range, treating each camera in each location as independent (just as program DataAnalyze does). Of course, such an analysis could be created by hand from output produced by DataAnalyze, however, GroupLocations does this much faster and flawlessly.

Another user has suggested the need for program Corridor that can identify when, where, and how long it takes a species to traverse a corridor between a pair of cameras. As with all the analysis programs Corridor starts with AllPictures.txt and InputTemp.txt (generated by DataOrganize). The user provides a list of paired cameras that act as possible corridors.

We have no doubt other users' ideas will benefit a growing global user community. Our hope is that camera trap surveying and monitoring programs will continue to expand, and at the same time begin mining the mountains of accumulated camera trap data that resides on countless hard drives across the world before it is lost.

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The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

Think before you plan: Introducing preplanning considerations in conservation

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Abstrak

Selama dekade terakhir, konservasi mengalami transisi dari yang semula fokus utamanya pada tujuan yang terkait erat dengan ekologi atau keanekaragaman hayati kepada tujuan-tujuan yang lebih mempertimbangkan kepentingan masyarakat (misalnya: sosial, ekonomi dan politik). Meskipun masih banyak tantangan secara teknis dan logistic, perencanaan multi-sasaran dapat mendukung analisa konteks konservasi baru ini, karena masalah konservasi merupakan satu kompleksitas yang saling bertautan. Didalam proses perencanaan konservasi multi-sasaran, elemen yang seringkali diperhatikan secara berlebihan adalah tahap pra-perencanaan. Tahap dimana kebutuhan akan perencanaan dikaji, metode/alat perencanaan yang tepat dipilih, tingkat investasi perencanaan ditentukan, kajian menyeluruh atas potensi kondisi penghambat dilakukan untuk memastikan dukungan masyarakat. Kajian pra-perencanaan secara menyeluruh sebelum mengambil keputusan perlu tidaknya perencanaan dilanjutkan akan lebih baik untuk mengaitkan berbagai resiko kegiatan dengan pendekatan yang diambil, tingkat investasi, dan keberhasilan upaya konservasi. Penyelarasan ini juga kemungkinan akan menghasilkan lebih sedikit rencana konservasi yang diabaikan dan hanya disimpan sebagai dokumen saja.

Abstract

Over the past decades, conservation has transitioned from focusing primarily on ecological or biodiversity-oriented goals to increasing consideration of goals related to human well-being (e.g., social, economic, political). Multi-objective planning can support analysis of these new conservation contexts but remains logistically and technically challenging because of the inherent complexity of conservation problems. Within a multi-objective conservation planning process, an often-overlooked element is the pre-planning stage. This is where the need for planning is assessed, appropriate planning tools are selected, the level of planning investment determined, and a horizon scan of potential 'disabling conditions' is undertaken to ensure the societal context is supportive. Explicit pre-planning prior to making a decision about whether or not a planning effort should go ahead would better align project risks with approach, level of investment, and potential conservation rewards. It might also result in fewer shelved conservation plans.

Keywords: biodiversity, disabling conditions, multi-objective planning, opportunity costs, pre-planning, trade-offs

Introduction

What is conservation planning? For something that most conservation organizations talk about, the term has a surprising range of interpretations (Pressey & Bottrill, 2009). Since the 1990s, it is most commonly associated with systematic conservation planning (Margules & Pressey, 2000), which involves a sequence of steps in a planning process that includes the establishment of quantitative goals for representing a set of biodiversity features in a suite of conservation areas. Any particular definition of conservation planning aligns it with the context and scale in which conservation is going to take place. A narrow definition, for example, could fit a relative simple conservation plan, such as one

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that aims to diversify micro-habitats in a temperate woodland swamp with the goal of increasing diversity and population size of rare dragonfly species. In this case, conservation interventions focus on local ecological processes and are unlikely to have broader societal implications. More often, however, conservation challenges are more complex. In those cases, there is a need for a broader definition of conservation planning that takes into consideration that conservation interventions could impact a range of social, economic and ecological processes. In the context of the present paper, we define conservation planning as a logical process at varying spatial scales for: 1) determining the need, purpose, and costs of planning; 2) identifying the ecological and societal context or situation in which a conservation program or project will take place; 3) establishing multiple objectives and trade-offs among them; 4) evaluating alternative strategies for achieving these objectives (including their costs and benefits); and 5) selecting preferred strategies (actions designed to achieve a specific goal). Prior to the actual development of a plan, there need to be particular pre-planning considerations.

In the past decade, conservation planning has evolved into a distinct sub-discipline of conservation biology, with well-developed theories and methods. The discourse around conservation planning has included frequent calls for planning approaches that integrate the perceptions and aspirations of the people who are likely to be impacted by conservation intervention (Cowling & Pressey, 2003; Knight et al., 2006; Pierce et al., 2005; Theobald et al., 2000). Consideration of the potential trade-offs between conservation and human development has a long history in conservation planning. Some of the conservation planning conducted during the 1970s and 1980s actively promoted the integration of conservation goals with those of economic development and natural resource extraction (Margules & Usher, 1981). The scope and context of conservation planning expanded further in the 1990s with the attempted integration of conservation and economic development goals within projects—i.e., Integrated Conservation and Development Programs (ICDPs)—and an increase in the sophistication of planning approaches for doing so (Wells & Brandon, 1993). Evaluations, however, suggest that the purported win-win approach of this integration often fell short of the rhetoric (Chan et al., 2007; McShane et al., 2011; McShane & Newby, 2004; Spiteri & Nepal, 2006; Tallis et al., 2008; Weber et al., 2011). This suggests that reconciling conservation and development objectives requires better planning that includes, inter alia, improving understanding of the societal context of conservation (Knight et al., 2006; Perhans et al., 2008).

Recently, a group of conservation practitioners from a range of conservation organizations and academic institutions, including the authors of this paper, evaluated conservation planning practice within The Nature Conservancy (TNC)—the world's largest conservation NGO—and made a number of recommendations for improvement (Planning Evolution Team, 2011). Two important recommendations that are relevant to general conservation planning were to: 1) improve plan implementation by paying greater attention to the planning context before a plan is initiated; and 2) aim for greater rigor without greater investment in planning. Improving planning does not mean increasing the volume of planning; it means planning more efficiently and ensuring that it is appropriate to the particular circumstances.

In this paper, we build on these recommendations and outline several inherent challenges facing conservation organizations undertaking multi-objective planning, emphasize the need for a pre-planning phase, highlight several considerations in the pre-planning phase, and provide specific recommendations on pre-planning methods.

Challenges inherent in multi-objective conservation planning

The conservation community is increasingly working with other sectors of society, such as natural-resource industries (e.g., mining, timber, and fisheries) or people living in areas of environmental concern. Therefore, conservation initiatives often involve planning for a wide range of objectives, in addition to the specific biodiversity or other conservation-oriented objectives. Yet predicting the influence of a conservation action on a biodiversity objective is a complex task. Conservation involves multiple interacting elements such as species, the physical environment, people, policies and regulations. Interactions between these elements are often non-linear, and small changes in one element can induce disproportionately major impacts in others (Snowden & Boone, 2007). Thus, multi-objective conservation planning needs a multiple criteria approach (Moffett & Sarkar, 2006), as well as consideration of non-linear relationships between components of a social-ecological system in which most conservation initiatives take place.

The inherent complexity also means that conservationists often fail to identify the potential conflicts among multiple objectives (Salafsky, 2011). One reason for this failure might be that it is not always clear under which circumstances objectives are conflicting. Oil palm plantations, for example, often impact local biodiversity negatively (Sheil et al., 2009), but whether or not biodiversity conservation and oil palm production have conflicting objectives depends on the ecological sensitivity of the area, the specific biodiversity elements involved, the size of the plantation, the alternatives to oil palm for producing vegetable oil, and the geographic scale at which the issue is assessed (Feintrenie et al., 2010; Meijaard & Sheil, 2013). In other words, local context frequently determines which objectives are in conflict and how trade-offs can vary across different temporal and spatial scales (ACSC, 2012). Solutions that are "win-win" will not always be possible (Sayer & Campbell, 2004).

Another challenge of multi-objective planning that includes socio-economic and ecological goals is that these goals increase the number of potential constraints. Understanding societal enabling and disabling conditions, such as market constraints, positive and negative economic incentives, and community resource management rights, becomes more important and challenging in multi-objective planning. Often programs are based on hopeful assumptions of political will, capacity, the ability to change behavior, and the eventual positive impact of the program, but "hope is not a planning tool" (Downes, 2012). Conservationists do not generally recognize the existence of situations in which positive outcomes are not possible unless key constraints are addressed—with a few exceptions (see Knight et al., 2010; Knight et al., 2011; McClanahan et al., 2008). In marine fisheries in the South China Sea, for example, resolving livelihood issues appears to be a prerequisite to solving fish conservation problems (Cheung & Sumaila, 2008). In Ghana, reducing the bush meat trade is constrained by a lack of sustainable fish supplies (Brashares et al., 2004). The mechanisms of failed conservation interventions are rarely reported (Knight, 2006; Redford & Taber, 2000), but in those cases in which they are, societal constraints are often important causes (Gibson & Marks, 1995; Knight et al., 2010; McClanahan et al., 2009; Webber et al., 2007; Wunder et al., 2008). In some cases, project failure and loss of conservation investment might have been avoided through rigorous assessments of disabling conditions.

Identifying disabling conditions requires reviews of societal and ecological conditions and trends (Cowling et al., 2008; Knight et al., 2006). Situation analyses or development of conceptual models (Conservation Measures Partnerships, 2007) involve such screening, however, these are generally only introduced after it has already been decided that a conservation plan is needed and conservation action will take place. Identifying and evaluating disabling conditions must be conducted before a conservation plan and strategies are developed.

The overlooked pre-planning phase

Prior to planning, a team should determine the best approach to planning and whether it is even needed. We consider such pre-planning to be different from the initial phase of conservation planning or "scoping" (Cowling & Wilhelm-Rechmann, 2007; Knight et al., 2006; Margoluis and Salafsky, 1998; Pressey & Bottrill, 2008, 2009). Such scoping is among others an obligatory component of the

Strategic Environmental Assessments that form the principal environmental planning framework in the OECD and many other countries (e.g., Australia, New Zealand, the U.S.A., and Canada). Scoping occurs when it has already been decided that planning will take place. Pre-planning, on the other hand, assesses explicitly whether a plan is needed and, if so, what type of plan will be best.

For consistency, planning efficiency, and a common language, conservation organizations like to standardize their conservation planning approaches. Standardized approaches can lead to overlooking specific local contexts in which planning and implementation may occur. Our review of conservation planning indicates that many conservation plans are unused because the planning and project contexts were poorly understood. Pre-planning requires that an open mind is maintained regarding the need for a plan, its scale (from simple to complex), potential audience, and the most suitable (rather than standard) method for developing the plan.

To illustrate our case for the need of a distinct pre-planning phase, we give an example from our own direct experience of the impact of insufficient consideration of planning and project contexts. Ecoregional Assessment is one of the standard methods that TNC and other conservation groups use to establish priorities for their conservation actions. This planning process assesses relatively large geographic areas delineated by large-scale patterns of climate, geology, biodiversity, and other ecological and environmental patterns. Several such assessments have been conducted in Indonesia, including, for East Kalimantan (Moore et al., 2003). Even though the resulting conservation prioritization patterns were insightful, the plans were not used to inform the choice of project areas, adapt land use plans or designate new protected areas. The reasons for the lack of take up of the plans vary, but one major factor is likely to be that decisions on land use and forest protection in Indonesia are more likely to be influenced by government regulations and socio-economic cost and benefits (McCarthy & Cramb, 2009), rather than ecological considerations. Such studies have consequently been put in place in Kalimantan, but a pre-planning phase might have identified the constraints of ecology-based planning up-front, and could have recommended incorporating the economic consequences of different land use options (for example, by looking at land use opportunity costs), and analyzing regional decision-making frameworks (how and by whom are decisions made?). The resulting plan could thus have had much more political relevance and might indeed have been used more effectively.

We reiterate that in a pre-planning phase two contexts should be evaluated:

Context of the plan. The first step of pre-planning is to consider the purpose of the plan, what decisions will come from it, and who will use the plan to make those decisions? Many conservation planners fail to ask the question of what they are planning for, and who will be accountable for and use the results. If such questions cannot be answered, a planning process ought to be terminated.

Context of the project. A second step in pre-planning focuses on the planning capacity of conservation staff and external stakeholders, the institutional complexity, the degree of stability in socio-ecological systems, the spatial context of the plan, the time and funding available for planning, and the particular requirements to include local, non-conservation objectives.

These pre-planning considerations should help determine whether actual planning should start, influence the choice of planning methods and tools, and guide the overall investment of time and resources into planning (Fig. 1). Discarding inappropriate and unsuitable standard planning approaches is difficult, because of the organizational tendencies to adhere to standard practices. Consequently, pre-planning should be done by people who are familiar with local contexts and are in positions to decide whether a project should be developed and which planning approaches should be used.

One constraint of implementing pre-planning is

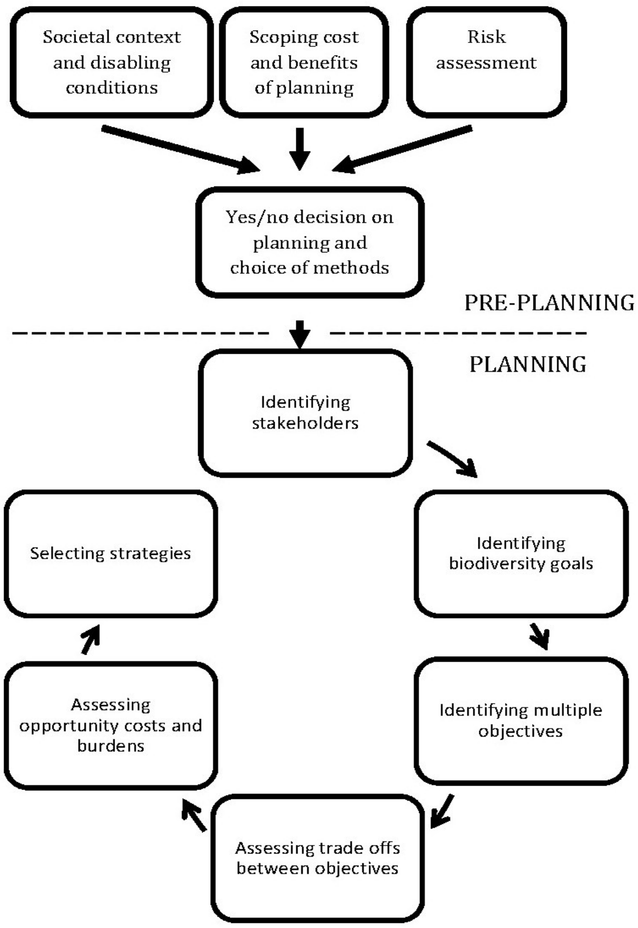

Figure 1. Schematic design of the conservation pre-planning and planning processes.

that project planning forms part of overall project management and is included in the project funding. Because pre-planning happens before commencing a project, it usually falls outside the normal donor funding cycles. Consequently, to save costs pre-planning should be undertaken quickly, for example using a simple checklist (Tab. 1) or other means of assessing planning and project feasibility as well as potential risks and rewards.

Pre-planning not only determines the context in which conservation planning will take place, it also indicates how much flexibility will be needed in planning. The idea of adaptive planning is reflected by Patton's (2011) suggestion that the heavy planning mode of "ready, aim, fire" might be less suitable than the "ready, fire, aim" approach. In some contexts it may be sufficient to propose a theory of change, and "avoid the tyranny of the project and logframe" (Keystone, 2012). Pre-planning is also designed to anticipate the likelihood of unforeseen events impacting the project negatively (i.e., a risk assessment) and suggest the type of planning approaches that allow for a suitable level of adaptability.

Considerations in the pre-planning phase

Here we highlight three contexts—biodiversity extents, opportunity costs, and conservation knowledge—which ought to be assessed in the pre-planning phase to determine the subsequent approach to planning. While there are other important contexts that could be considered in pre-planning too, we select these three because project planners often make assumptions (as part of standardized methodologies) about them. We use these three elements to illustrate how consideration of context may change the type of planning that should occur.

Biodiversity extent

Some landscapes are characterized by large and abundant areas of high conservation value (e.g., the Amazon Basin). Other areas have geographically localized regions of high conservation value in a broader landscape of low conservation value (e.g., the remaining forest patches on the Philippine islands). In between are a few fragmented landscapes of high conservation value (e.g., South Africa's Cape Floristic Region). Each requires different approaches to conservation planning. The initial conservation goal in areas of widespread conservation value is frequently to reduce the decline of biodiversity. Conservation gains can be made in one area or another with near equal benefits. In areas of widespread high conservation value, conservation planning might emphasize objectives relating to community support, political expedience, and maximizing broader conservation outcomes. Such situations are common in tropical countries where most of the world's biodiversity is concentrated (Hoffmann et al., 2010; Leadley et al., 2010). In areas where high conservation value sections are scarce or fragmented due to high human population densities and high rates of habitat loss, the immediate goal is to secure as many fragments as possible and maximize their ecological integrity and connectivity at minimal cost. Strategic choices between different conservation fragments require trade-off analyses, especially as modified landscapes are correlated with high costs for effective conservation. Spatial prioritization tools are primarily focused on navigating the latter situation. The context in countries with widespread high conservation value should not preclude the use of sophisticated prioritization software (see Game et al., 2011; Meir et al., 2004), but the pre-planning phase should ensure that the objectives relevant to the decisions at hand, merit its use. If local political decision makers are not willing to integrate information from land-use optimization or ecoregional planning exercises into decision making, such planning exercises are futile and merely incur unnecessary expenditures.

Opportunity costs and burdens

Conservation may preclude land-use alternatives and thus create opportunity costs, i.e., the value of the most lucrative alternative not chosen. In poorer countries, conservation works partly on credit by foregoing current revenues from natural resource use for potential future gains, whereas in wealthier countries, capital is often provided up front, for example, for buying land or conservation easements. In both cases it is reasonable for conservation organizations to strive to minimize opportunity costs. However, in wealthier countries, an acceptable opportunity cost constitutes a broader societal decision and one that should be presented clearly in terms of what can be gained for a given level of incremental cost outlay (e.g., Game et al., 2008). In poorer countries, an acceptable opportunity cost is usually decided locally in a context that is heavily dependent on fine-scale variation in social adaptive capacity and environmental conditions (McClanahan et al., 2008). Pre-planning needs to anticipate that implementing conservation programs under variable opportunity costs may influence the support of people and institutions directly or indirectly associated with the project. To what degree are the people affected by the conservation interventions willing to forego earnings from the natural resources that conservation seeks to protect, and is the international conservation community willing to adequately compensate the affected people?

Conservation knowledge

Education levels are important predictors of conservation success (Jacobson, 2010; Launio et al., 2010; Waylen et al., 2010), and different levels of technical knowledge and scientific thinking need to be considered before choosing a conservation planning approach. If conservation organizations have to work with unfamiliar or complex planning tools and datasets that they do not fully understand, they will find it difficult to convince project stakeholders of the usefulness of the planning outcomes. One of us (CRG) experienced difficulties in getting program directors to accept "high-priority conservation areas" results generated with the help of decision support software, because the directors viewed it as a "black-box." The planning approach, therefore, needs to adapt to the local planning capacity, and how the results of planning are most effectively articulated (e.g., oral or written; top down or bottom up). Capacity assessment at the pre-planning stage stand a much better change of producing better planning outcomes.

Conclusions

Even in conservation projects that primarily focus on the singular objective of biodiversity conservation there is a well-known gap between planning and implementation (Knight et al., 2008). Conservation projects that are explicitly addressing multiple objectives, including those related to human well-being, are inherently more complex. While we believe that considering multiple objectives is a precondition for implementation, the increasing complexity also risks that planning becomes more abstract. We recommend that pre-planning processes are introduced to understand how complexity and particular contexts affect planning and project implementation.

We recognize that pre-planning to some extent exists in conservation organizations and other organizations engaged in biodiversity conservation. Organizations make strategic assessments of the risks and potential rewards of investing in certain countries, regions, strategies, or new markets. Also at national and sub-national level, there are strategic organizational processes that assess these risks and rewards. We believe our pre-planning recommendations will add most value in the context analysis at project level, when it is possible to determine whether a project is going to fail or succeed. Subsequently, a pre-planning team can provide recommendations to accept or reject the project, the type of planning that should be considered, duration over which a project should be attempted before deciding to discontinue it, and the funding for the project. Whereas pre-planning may add to organizational bureaucracy, it will ultimately increase conservation performance by effectively aligning project risks, approaches, investments, and rewards. The key to successful incorporation of pre-planning is to keep it simple.

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Table 1. A checklist of relevant questions that could be asked during the pre-planning phase and their possible answers and conclusions. This list is not meant to be exhaustive, but provides guidance as to what could be considered during pre-planning.

Relevant questions	Possible answers	Possible conclusions
Why is the plan needed?	Because we have no idea what to do.	You need a plan, or a review of the rationale of your work.
	We know what to do, but everyone else tells us that a plan is needed.	You might only need a simple plan that formalizes what you already know.
	Because we need to develop a coherent approach to solving the problems identified.	A detailed planning process with stakeholders may be warranted.
Who will be accountable for and use the results of the plan?	Ourselves	The plan is primarily for internal communication and guidance.
	Government	Link to existing government plans, and assess trade-offs with conservation. Keep it simple.
	Local communities	Ask them whether they want a plan; what should be planned for and over what time-scales.
Does it make a difference where investments are made in terms of conservation value?	No, any site we choose would have high conservation value, or conservation values do not feature in local land use decisions.	Spatial prioritization planning might not be the most useful planning tool.
	Yes, some sites have much higher conservation values than others and are locally appreciated.	Spatial prioritization planning might be useful.
How are decisions about conservation values made in the area of interest?	Top-down, power-based	Plan for conservation trade-offs most relevant to decision makers.
	Bottom-up, democracy-based	Plan for conservation trade-offs most relevant to a local public that ultimately drives decisions.
	Informed by science and rational thinking	Use one of the many scientific conservation planning tools.
Are there any obvious enabling or disabling conditions?	There are certain factors that make it unlikely that conservation will work.	Focus planning on addressing disabling conditions rather than trying to achieve impossible conservation goals.
	Local factors such as public support make it likely that conservation will work.	Focus on bottom up planning that involves local stakeholders.
Are there any obvious risks to our project's success?	Yes, but the potential gains outweigh the risks.	Proceed with standard planning approaches.
	Yes, the risks of failure are very high.	Reconsider whether a plan is useful, or focus plan on minimizing risks or maximizing leverage from success.
	No, there are minimal risks.	Recheck the risk assumptions.
Do existing plans (including by other organizations) fully or partly fulfill planning needs?	Yes, existing plans are useful.	Consider how existing plans can be incorporated and assess what the take up of those plans has been.
	No, there are no other useful plans	Consider why there are no other plans (lack of data) and how these reasons could affect present planning processes.
How does data availability relate to data needs for planning?	There are sufficient data for present planning needs.	Choose planning method that is in line with data availability.
	Planning may be data-limited	Consider whether an investment in data gathering is worthwhile investment, or choose a planning tool that uses data that are easily obtained, reliable and readily available.

Short communications

Using leopard cats (*Prionailurus bengalensis*) as biological pest control of rats in a palm oil plantation

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Introduction

Oil palm plantations constitute ideal habitat for several species of rats with a variety of shelter and constant food supply year around. In an ideal habitat rat populations can become so dense that they become one of the most serious pests in oil palm estates. Large rat populations can cause serious damage to fruit bunches resulting in significant economic loss. Studies have recorded losses in excess of US$ 32 million annually for the industry in Malaysia in the 1980s (Basri & Halim, 1985). The damage by rats is estimated at 5% to 30% of average yield if no pest eradication activities are undertaken (Hafidzi & Saayon, 2001; Wood & Chung, 2003).

The most common method of controlling rat populations is application of anticoagulating chemical rodenticides. These are traded under brand names such as Warfarin (*(RS)-4-Hydroxy-3-(3-oxo-1-phenylbutyl)-2H-chromen-2-one*), Bromadioline (*3-[3-[4-(4-bromophenyl)phenyl]-3-hydroxy-1-phenylpropyl]-2-hydroxychromen-4-one*) and chlorophacinone (*2-[2-(4-Chlorophenyl)-1-oxo-2-phenylethyl]indane-1,3-dione*) (Chong et al., 2011; Hafidzi & Saayon, 2001; Joshi et al., 2002). Extensive use of chemical rodenticide can greatly add to the average plantation's operational budget. In many cases it has also resulted in developing physiological resistance in the target pest species (Baker et al., 2007; Smith et al., 1993). In addition, there is a high risk of incurring serious residual effects on humans, particularly the workers applying the rodenticides (Joshi et al., 2002). For all of these reasons, biological rodent control was introduced in earnest in the early 1980s (Duckett, 1984). The barn owl, *Tyta alba javanica*, is the most widely used bio- rodenticide in palm oil plantations today (Chong et al., 2011). Some companies proclaim zero- use of chemical rodenticide, and they breed more than 10.000 barn owls annually for their plantations (Indofood Agri Resources Ltd. , 2012). Barn owls have proven excellent as bio-rodenticides. They are effective predators and they are able to establish local populations relatively well, as long as plantation owners deploy enough nest boxes (Naim et al., 2011). However, it is not certain whether barn owls are effective in reducing rodent populations that have grown to very high levels (Chong et al., 2011; Wood & Chung, 2003). Barn owls have proven effective in regulating rodents' damage to fruit bunches when rat populations are relatively low. However, studies suggest that without using aids such as rodenticides barn owls are unable to reduce rodent population effectively when rat populations are very high (Chia & Lim, 1995; Chong et al., 2011; Smal et al., 1990).

Very few estates have explored the opportunity of using other bio-rodenticides to substitute and/

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Figure 1. Leopard cat, *Prionailurus bengalensis*, stalking rats in an oil palm plantation in Central Kalimantan, Indonesia.

or compliment barn owls. A common predator in oil palm plantations is the leopard cat, *Prionailurus bengalensis* (Azlan et al., 2013; Grassman, 2000, 1998; Grassman et al., 2005a, 2005b; Rajaratnam, 2007) (Fig.1). With a body-weight ranging between 2.5-4kg it is considerably larger than a barn owl's 0.4-0.7kg. Therefore, it is expected to consume much more food and it may be a better bio-rodenticide than barn owls, provided the cats are are found in sufficiently large numbers.

This study aims to assess the effectiveness of the leopard cat at controlling rat populations in an oil palm plantation in Central Kalimantan, Indonesia.

Methodology

Study location

This study was conducted from 17th September to 17th October, 2012, in an oil palm plantation in Central Kalimantan province, Indonesia. Elevation range is 7-13m above sea level. The habitat consists of six year old oil palms.

Camera trapping

20 units of "Keep Guard Cam TM1" camera traps were deployed in a 1600m x 2000m trapping grid with the distance between cameras 400m. The cameras covered two different treatment areas in which rat population densities were estimated;

Site A: area with solid mill effluent and empty fruit bunch application.

Site B: control area (no treatment).

Camera traps were set to be active throughout 24 hours cycles. The motion detection was set to "medium" to avoid too many "ghost" pictures occurring from leaf and grass wind-movements. The cameras were set to take three photos at one seconds intervals (one independent event), and 10 seconds difference between events. Camera traps were fixed to wooden poles 0.6m above ground.

Picture analysis

All pictures were organized and analyzed following the method developed by Sanderson and Harris, 2013). Species photographed were identified according to Francis (2008) and Payne and Francis (1985).

Table 1. Six different animal species were recorded by camera traps in the two study sites, and two species of rats were captured in the area.

Species	#captures
Camera traps	
Prionailurus bengalensis	125
Felis domesticus	122
P. hermaphroditus	7
Centropus sinensis	3
Streptopelia chinensis	1
Homo. s. sapiens	97
Unidentified objects	162
Total	**517**
Cage traps	
Rattus argentiventer	208
Rattus jalorensis	45
Total	**253**

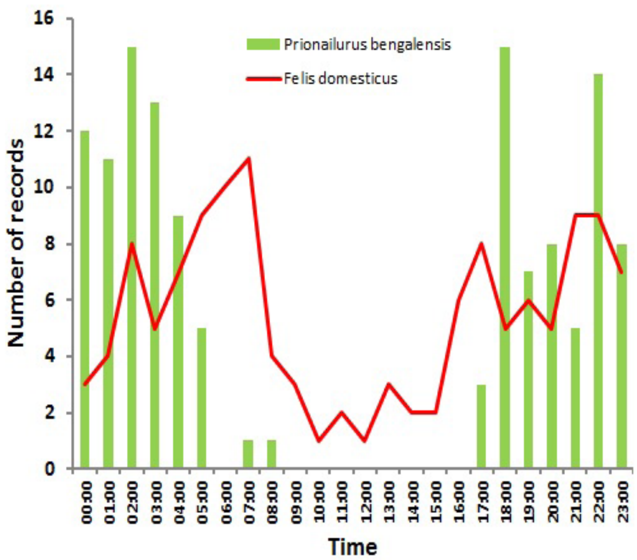

Figure 2. The diurnal rhythm of leopard cats (green columns) and feral cats (red line) in an oil palm plantation in Central Kalimantan, Indonesia.

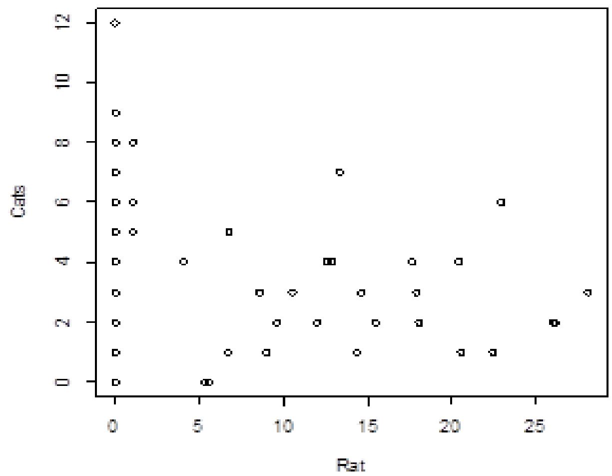

Figure 3. The relationship between cat and rat population in two study sites in an oil palm plantation. Spearman's rank correlation, $p< 0.0005527$, $\rho = -0.4328$.

Population estimates of rats

Concurrently with the camera traps we deployed 50 cage traps (15x20x40cm) in five trap lines with each 10 traps in each study site. The distances between the trap lines and the individual traps were 20m. The cage traps were positioned on the ground, baited with fresh coconut and checked twice daily in the early morning and in late afternoon. Each captured rat was marked by fur clipping and released. We used capture-mark-recapture method to estimate the rat population density (Jolly, 1965).

Results

A total of 517 images were recorded by camera traps during 608 trap nights. Leopard cats (*Prionailurus bengalensis*), feral cats (*Felis domesticus*) and humans were by far the most common captured with 125, 122 and 97 images respectively (Tab. 1). Palm civet (*Paradoxurus hermaphroditus*), Greater Coucal (*Centropus sinensis*) and Spotted dove (*Streptopelia chinensis*) were also recorded along with unidentified objects. Two species of rats *Rattus argentiventer* and *Rattus jalorensis* were captured during a total of 3000 trap nights (1500 traps nights in site A and 1500 traps nights in site B).

Camera trapping revealed leopard cats and feral cats as active predators of rats in both study areas, with several cameras recording both leopard cats and feral cats feeding on rats. The presence of both species did not seem to negatively affect the other cat species, since leopard cats are strictly nocturnal and feral cats exhibit crepuscular and diurnal activity pattern (Fig.2).

The rat population was estimated at 0.07 individuals/ha in Site A with a cat abundance of 0.89/ha in contrast to 7.29 individuals/ha (rats)in Site B with a cat abundance of 0.58 individuals/ha. There was reverse correlation between cat and rat populations ($p<0.01$, $\rho= -0.4328$, Spearman's rank correlation) with high abundance of cats resulting in low population of rats and vice versa (Fig. 3).

Discussion

Murids constitute the majority of the prey base for leopard cats in general (Grassman et al., 2005; Sakaguchi & Ono, 1994; Yasuma, 1981). The dominating percentage of murids in the diet of leopard cats is expected, in consideration that murids dominate terrestrial small-mammal communities in tropical rain forests (Wells et al., 2004). In an oil palm plantation rats are also the dominant small mammal, to the extent that it is considered a pest animal. An earlier study in Sabah, Malaysia, revealed that murids comprised 92.8% of the mammalian prey consumed by leopard cats (Rajaratnam et al., 2007), suggesting that leopard cats are indeed significant predators of rats in a plantation landscape. The presence of feral cats does not seem to affect the distribution of leopard cat in the plantation landscape as both species generally recorded from the same areas. In general, however, feral cats are more abundant close to human habitations (housing area, mill, offices), whereas leopard cats seem to prefer less disturbed areas. From a rat controlling perspective, it seems that the presence of both cat species may be an advantage, because when both are present their combined hunting pressure is extended from 18:00-05:00 to a 24hour cycle (Fig.2).

In comparison to barn owls, leopard cats are expected to consume more rats per individual, simply because the larger cats require more energy to sustain their bigger body mass. However, this does not necessarily mean that leopard cats are more effective rat-controllers in oil palm plantations. Considering that total off-take of rats depends on predator population size, a large barn owl population may be more effective rat controllers than a small leopard cat population. A study by Chong et al. (2011) recorded a rat population of 0.09 rats/ha using barn owls as rat controllers, which appears less effective than that recorded in this study with leopard cats. Unfortunately, Chong et al. (2011) does not report the numberrs of the population of barn owls in their study; therefore, it is not possible to make direct comparisons between these two studies.

This study suggests that leopard cats, *Prionailurus bengalensis*, can be very effective rodent controllers in oil palm plantations. Although it is not possible to compare the rat controlling effect of leopard cat with that of barn owls, *Tyta alba javanica*, there is enough evidence for plantation operators to consider improving the habitat conditions for a native larger predator rather than spending significant additional funds to purchase and erect thousands of nest boxes for barn owls in areas where it is not native. From a conservation perspective, the introduction and promotion of barn owls is an unnecessary expenditure. In Central Kalimantan, barn owls are exotic species that may compete with a native mammal species such as leopard cats which are already present and effectively maintain rat populations at levels that are economically insignificant to palm oil production. However, more studies are needed to determine to what degree leopard cats and barn owls may increase rodent predation pressure or reduce it due to intraspecific competition.

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Food preference of the Javan tree frog (*Rhacophorus margaritifer*) in Mount Gede Pangrango National Park and Cibodas Botanical Garden, West Java

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Introduction

The Javan tree frog, *Rhacophorus margaritifer,* is endemic to the island of Java (Fig.1). Its current stronghold includes the mountain range from Mount Gede-Pangrango National Park to Cibodas Botanical Garden in forested habitats at altitudes between 1400 meters above sea level (Ciwalen) to 1800 masl (Swamp svelte) with highest abundance in Cibeureum (1700 masl) (Kusrini et al., 2007; Lubis, 2008). It is also found in Mount Merapi National Park and in East Java around the Ijen plateau. The species is listed as “Least Concern” by the IUCN Red List 2009 (Iskandar et al., 2009) and not listed as a protected species by the Government Regulation 7 of 1999. The population density is believed to be stable (Kusrini et al., 2007) although habitat loss and disturbance are becoming increasing threats to its existence.

Very little is known about the species’ behavioural ecology and population biology. Research about the food and feeding behaviour of *R. margaritifer* is important to understand its conservation needs as well as to develop effective conservation interventions. Like many other frog species the Javan tree frog feed on a range of insects, and it is possible that the species is an important predator of several species of insects that are considered pests and potential carriers of diseases. Therefore, protection of the Javan tree frogs’ key habitats is critical to ensure the long-term conservation of this endemic species.

This study aims to determine the food and feeding behaviour of *R. margaritifer*, and to estimate the niche width and overlap based on available food resources.

Methods

Location and Time

Data collection was carried out in the area sampled around the waterfall Cibeureum and Ciwalen (Gede-Pangrango/TNGP Mountain National Park) and the Botanical Gardens Cibodas (KRC) between the months of April-June 2009.

Capturing

73 specimens of *R. margaritifer* were captured between 8:00 p.m. and 22:00 p.m. (10 at KRC, 5 and 58 at the waterfall Ciwalen Cibeureum) using torchlights to identify eye-shine. We measured the snout-vent length (SVL) and body weight, and recorded the type of substrate at capture sites and time of capture. Captured specimens were temporarily stored in plastic bags for further analysis of their stomach contents. After analyzing the stomach contents the frogs were released back on the same site as they were captured.

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Figure 1. An adult Javan tree frog, *Rhacophorus margaritifer.* The species is endemic to the Indonesian island of Java. © Luthfia Nuraini Rahman

Stomach flushing
The stomachs of captured specimens were flushed using the method described by Legler and Sullivan (1979). Before stomach flushing frogs were put under mild anesthesia using *Tricaine methanesulfonic* anesthesia (MS-222) with a concentration of 1% (Hirai and Matsui, 2001). Stomach contents were removed by pouring water into the stomach with a small tube following gentle stomach massaging on frogs in a position with the head facing downward. Extracted stomach contents were preserved in 70% alcohol for later analysis.

Food availability
We assumed that *R. margaritifer* feed on primarily insects that are found in the same habitat. Prey specimens were collected by hand and by a light trap using a 52mm diameter candle as light source placed in the middle of the box trap (Borror et al., 1996). Captured specimens were placed in plastic bags and injected with 70% alcohol and preserved in 70% alcohol solution. Preserved insects were taken to the Laboratory of Entomology, Faculty of Forestry for identification and analysis.

Data Analysis
Collected prey specimens were grouped by type (insect: larva and imago, spiders, plants, and other) and identified to order. The abundance of each order, overall composition and prey volume was calculated using the equation for the ellipsoid distribution (Dunham, 1983; Hirai and Matsui, 2000). Correlation between specimens' body size with food volume was tested using Pearson Product Moment correlation equation. Student's t-test was used to test for possible differences in volume of food consumed by male and female *R. margaritifer*.

Results

Food composition
A total of 73 *R. margaritifer* was collected consisting of 65 males and 8 females. The stomach of 33 individuals contained food with the remaining 40 empty. In total, 39 food items were extracted of which 35 items derived from male frogs and 4 females. Seven items were not identified, because the conditions were too poor.

The identified food items belonged to three different Classes (*Arachnida*, *Insecta* and *Gastropoda*) in 11 orders (Tab.1). The result showed that insects (70.27%) constituted the most common prey item followed by *Arachnida* (18.92%) and *Gastropoda* (10.81%). Amongst the insects *Orthopteras* are most commonly consumed (23.08%) (Table 1).

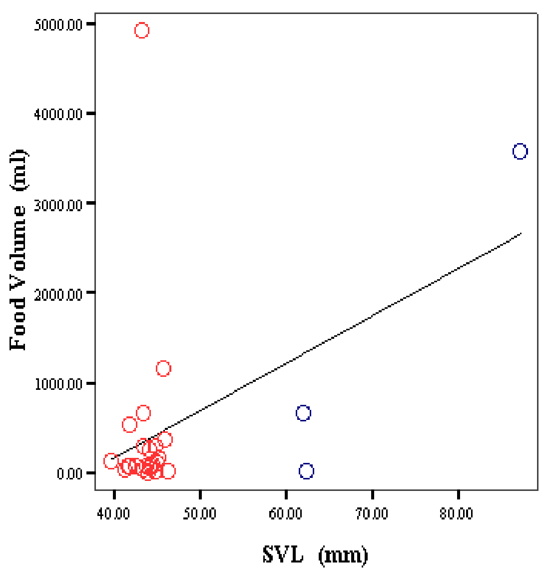

Figure 2. There is a positive correlation between food volume and SVL (Pearson, r = 0.402).

Food volume

The amount of food volume from each individual of *R. margaritifer* ranged from 0.003–6.355ml with an average of 0.937ml. The SVL ranged from 39.65-87.32mm with an average of 46.68mm. Pearson correlation test returned a positive correlation between food volume and SVL (r = 0.402) (Figure 2). The average food volume of females (2.317ml) was higher than the average food volumes extracted from males (0.764ml).

Food availability

The survey resulted in capturing species belonging to nine orders of insects, one *Arachnida* order and one order of *Gastropoda*. *Orthoptera* were the most commonly consumed insect (27,42%) with the *Aranae* and *Pulmonata* reaching only 16,13%. Results of correlation analysis between habitat and abundance of insects in the stomach sample showed a significant correlation (r = 0,678).

The food availability survey from each location revealed that the Cibeureum waterfall area was dominated by *Orthoptera* (26,67%), the Ciwalen area dominated by *Orthoptera* and *Hymenoptera* (50%) and the Botanical Gardens had many *Pulmonata* (60%) (Tab.1).

Food selection

Kendall's correlation analysis suggests that *R. margaritifer* prey opportunistically on available insect species (τ = 0.934). Males (τ = 0.967) have a higher degree of food-variety than females (τ = 0.879).

Niche selection

Applying the Levins index the results indicate that *R. margaritifer* occupies a broad niche in their habitat (BA = 0.642). However, there is a big difference in niche occupancy between male and female *R. margaritifer*. Female *R. margaritifer* tend to utilize narrower niches (BA = 0.167) than male *R. margaritifer* (BA = 0.642).

Tabel 1. The food composition of the Javan flying frog, *Rhacophorus margaritifer*, sampled from Gede-Pangrango National Park and the Botanical Gardens Cibodas between the months of April-June 2009.

Class	Order	*Rhacophorus margaritifer* Male	*Rhacophorus margaritifer* Female	Total	Food preference Order (%)	Food preference, Class (%)
Arachnida						18,92
	Aranae (adult)	6	-	6	15,38	
	Aranae (eggs)	1	-	1	2,56	
Insecta						70,27
	Orthoptera	8	1	9	23,08	
	Larva	6	-	6	15,38	
	Lepidoptera					
	Hymenoptera	4	-	4	10,26	
	Coleoptera	1	1	2	5,13	
	Blattaria	3	-	3	7.69	
	Embiidina	2	-	2	5,13	
	Isoptera	1	-	1	2,56	
	Dermaptera	1	-	1	2,56	
Gastropoda					10,26	10,81
	Pulmonata	2	2	4		
Unidentified		6	1	7		
Total		**41**	**5**	**46**	**100**	

Discussion

The availability of food constitutes one of the most important features of a specific habitat. It is not only the volume of available food that is important, but also the quality of the food. This is particularly important during the reproductive season. The ability to uptake and process food also depends on the stomach size of an individual, which is usually correlated to the body size. The results of this study indicate that there is a positive correlation between body length (SVL) with a food volume of individual *R. margaritifer* i.e. the larger body size the more food they consume. Since females are usually larger (SVL: 70.54mm) than male *R. margaritifers* (SVL: 43.77) (this study; Hodgkinson and Hero, 2002) it is not surprising that food volumes recorded from female individuals were larger than volumes recorded from males (♀ = 2,317ml; ♂ = 0.764ml). Females also need additional energy uptake during mating season, where they search for the most suitable places to lay eggs and produce a foam-nest (Grzimek, 1974). Apart from needing more energy to sustain a bigger body size, females are more selective in their food choice than males. Although this study did not measure the energy value of selected food items, it is likely that females select prey items with higher energy value than the more opportunistic males.

Many species of amphibians are described as opportunists who take advantage of the resources available in their habitat (Hofrichter, 1999). This study suggests that *R. margaritifer* follow the same pattern, although males and females show varying degrees of feeding opportunism. Elliot tand Karunakaran (1974) reported that *Fejervarya cancrivora* is a very opportunistic species that will feed on *Crustaceae* when insects are scarce. This habit is also recorded in *R. margaritifer* that feed on *Pulmonata* and *Araneae* in addition to insects. *Rhacophoridae* usually forage by ambush where they wait until a suitable prey is within reach of its elastic tongue (Duellman and Trueb, 1994; Grzimek, 1974). Not surprisingly, the most commonly consumed prey items belong to the *Orthopteras* (23.08%) and *Hymenoptera* (10.26%) that usually live on the surface of leaves and are easy to find. Similar preferences are recorded in *L. cruentata* (Kusrini et al., 2007), *Leptobrachium haseltii* (Sasikirono, 2007), *Hyla japonica* (Hirai and Matsui, 2000), *Rana porosa brevipoda* (Hirai and Matsui, 2001), and *Fejervarya cancrivora* (Premo and Atmowidjojo, 1978).

This study suggests that *R. margaritifer* utilizes a diverse range of food resources (Tab.1). This correlates well with the Levin's index that indicates *R. margaritifer* occupies a broad niche, with males (BA = 0.642) occupying a broader niche than females (BA = 0.167). Nurmainis (2000) reported that for the paddy frog, *Fejervarya cancrivora*, individuals with large body size occupied broader niches and were more opportunistic than individuals with smaller body size. Whereas this may also be true for the *R. margaritifers,* this study also reveal that the food preference and niche utilization is also correlated to the specific sex of the individual.

When there is a high degree of interactions between organisms and individuals, including competition, predation, parasitism and symbiosis, there is also a significant niche overlap (McNaughton and Wolf, 1990). The *R. margaritifer* in this study exhibited a high degree of niche overlap between males and females. This may explain, along with females' higher need for quality food, the smaller males' tendency to rely on opportunistic foraging, because competing with females for quality food is too high.

The opportunistic feeding behaviour of the Javan tree frog may be key to its long-term survival. While it remains abundant in several key areas, it is dependent on pristine streams for breeding purposes, and its habitat has been steadily declining during the past two decades. More studies about the ecology of this species is important for developing effective long-term conservation interventions.

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First evidence of mutualism between Pied Fantail (*Rhipidura javanica*) and Bornean Red Muntjac (*Muntiacus muntjak*)

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Introduction

Symbiotic relationship between species is believed to have evolved, because it offers ecological advantage and workable solutions to many of the basic problems of health and survival (Margulis, 1981; Watson and Pollack, 1999). Mutualistic relationships are common across a wide variety of species, such as cleaning relationship between Caribbean cleaning gobies (*Elacatinus evelynae*) and long finned damselfish (*Stegastes diencaeus*) (Cheney and Cote, 2005), aphid insects and the bacterium *Buchnera aphidicola sp*. (Toft et al., 2009), Clown fishes and sea anemones (Fautin, 1991) as well as pelagic thresher sharks (*Alopias pelagicus*) and cleaner fish (*Labroides dimidiatus*) (Oliver, 2011).

Mutualistic relationships between bird and ungulates are very common. Red-billed oxpeckers (*B. erythrorhynchus*) are often seen plucking ticks from a wide range of wild and domestic ungulate (Hart et al, 1990) (Fig.1), although the exact nature of the symbiosis remains poorly understood (Weeks, 2000). Fan-tailed ravens (*Corvus rhipidurus*) and camels (*Camelus dromedarius*), Scrub Jays (*Aphelocoma coerulescens*) and Columbian black-tailed deer (*Odocoileus hemionus columbianus*), Black-billed magpies (*Pica pica*) and Fallow deer (*Dama dama*), Yellow-bellied Bulbuls (*Alophoims phaeocephalus*) and klipspringers (*Oreotragus oreotrugus*), Pale-winged Starlings (*Onychog n. nabouroup*) and mountain zebras (*Equus zebra*) and birds and capybaras are all well-described mutualistic bird/mammal relationships (Genov, 1997; Isenhart and DeSante, 1985; Lewis, 1989; Penzorn and Horak, 1989; Roberts, 1993; Tomazzoni et al., 2005).

There are a lot fewer observations of avian-mammal symbiosis from tropical forests. It remains to be seen, however, whether this should be attributed to the fact that (1) these habitats support far fewer species and lower densities of large-bodied terrestrial herbivores, or (2) far less is known about the behavior and interspecific associations of tropical forest vertebrates. Peres (1996) reported one of the few bird and ungulate interactions from tropical rainforests - in this case the Amazon - where Black caracara (*Daptrius ater*) and Pale-winged trumpeter (*Psophia Zeucoptera*) were observed providing "cleaning" services to lowland tapirs (*Tupirus terrestris*) and gray bracket deer (*Mazama gouazoubira*).

During a study in Kalimantan tropical forest, we recorded a symbiotic relationship between Pied fantail (*Rhipidura javanica*) and Bornean red muntjac (*Muntiacus muntjac*). This paper describes what we believe to be the first evidence of bird-mammal mutualism observed in a Southeast Asian tropical rainforest.

Study Areas and Methodology

The study site is located in Kota Waringin Barat, Central Kalimantan Province, Indonesia. The area consists a mosaic of forest patches and open grassland. The forest patches measured

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Figure 1. Mutualism between birds and mammals is a common phenomenon. Even large birds, such as the Slender-billed crow, *Corvus enca*, are often observed feasting on ectoparasites found on Java deer, *Rusa timorensis*, in Baluran National Park (left). Red-billed oxpeckers, *Buphagus erythrorhynchus*, are common in Sub-Saharan Africa, where they feed almost exclusively on what they can collect from the skin of large mammals (right). © Carl Traeholt / Copenhagen Zoo)

approximately 140ha consisting of a combination of selectively logged *Dipterocarp* and swamp forest habitat. The surrounding grassland is a result of recent deforestation and dominated by grass and fern species such as *Imperata cylindrical* and *Gleichenia linearis*. The altitude ranged from 35-43m asl.

We deployed 13 digital camera-traps (Trail Cam) randomly in two patches of forest between May and July, 2012. All cameras were set to "high" sensitivity and video mode with 10 seconds shooting interval and 60 seconds recording duration. Video mode was selected to allow for both species identification and behavioral observation. The cameras were checked once per month, and videos were downloaded and analyzed.

Result and Discussion

We recorded two incidents of symbiotic interaction between Pied fantail and Bornean red muntjac on the 14th and 18th of May, respectively. The first interaction lasted for 50 seconds. A male and female muntjac were seen feeding on the "Asam-asam" fruit (*Tetramerista glabra*) that had dropped to the ground. During the feeding session a Pied fantail moved between the ground and a small 75cm tree seedling in what appeared to kindle the muntjacs into accepting it landing on them. Eventually, the fantail landed on the rump of the male muntjac after which it stopped feeding for 50 seconds and took a position that allowed the fantail to move freely between its hind legs as well as its back to feed. This interaction is similar to the one observed between Black-tailed deer and Scrub-jays (Isenhart and DeSante, 1985; Olubayo et al., 1993).

Although bird-mammal symbiotic interactions are rarely observed in tropical forests, it is likely a common event that is difficult to observe in a dense rainforest habitat. How common such interactions are and to what extent the bird-mammal relationship is mutually beneficial remains a question, however, in most cases the relationships are obligate for the birds. Studies have shown that "cleaner" birds do not necessarily reduce ectoparasite loading on the mammals on which they feed, and sometimes have outright negative impact on the host's wound-healing abilities (Weeks, 2000).

The symbiotic relationship between birds and mammals is likely more complex than previously anticipated. However, the Pied fantail and the muntjac recorded on our video exhibited familiarity with each other, which suggests that such events have developed from past experiences, either between the respective bird-mammal individuals, or in general.

The Pied fantail-muntjac observation demonstrated the advantage of selecting "video-mode" setting for camera-trapping surveys. It provided behavioural insights into the interaction between bird and mammal that would not have been possible in "still picture" mode. We hope that this observation will promote more studies on this topic, to improve our understanding of bird-mammal symbiosis in tropical rainforest habitats.

Acknowledgement

We would like to express our gratitude to PT. Surya Sawit Sejati for making available the necessary resources for the study; to Rudianto, Sakti Angara, Ummi Farikha, Bjorn Dahlen and Dr. Wilson Novarino for their constructive discussion and advice.

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Students' research projects

Indonesia and its neighbours are considered some of the most biodiversity rich areas in the World. The sustainable use of the region's natural resources and the conservation of the rich biodiversity relies primarily on the current research and conservation effort taking place and, perhaps more importantly, on encouraging and facilitating committed and passionate students to maintain interest in these enormously important topics. This section is made available entirely to highlight MSc and PhD students' projects in the region that contribute enormously to building the foundation for future conservation interventions and initiatives.

Orangutans as Seed Dispersers

Esther Tarszisz (Australia)
OuTROP / University of Wollongong Australia. PhD candidate.

Animal-mediated seed dispersal is crucial for maintaining natural forest ecosystems. Orangutans (*Pongo pygmaeus*) are thought to play a significant role in animal-mediated seed dispersal due to their large body size and home ranges, however this information is critically lacking throughout all their habitat. I will undertake the first comprehensive analysis of seed dispersal by orangutans, by monitoring an orangutan population within the Sabangau River catchment, Central Kalimantan, Indonesia. This subject is vital, as seed dispersal and germination are crucial for maintaining natural forest ecosystems; orangutan populations are decreasing rapidly in many areas owing to human activities, yet the impacts of these losses on forest processes such as seed dispersal, and thus how these might be mitigated, are very poorly known; and this research serves as a potential model for understanding the importance of other forest fauna in, and effects of losses of these populations on, seed dispersal. Orangutan handling, ingestion and elimination of seeds will be investigated, and germination and plant establishment trials will be conducted. Data on orangutan behavior, movement and physiology; as well as floral composition of the study site will be utilized in order to gain a comprehensive picture of seed fate and develop a mechanistic model of the orangutan's role in it. This will determine the orangutan's importance role in this important component of forest ecology and provide the ability to predict effects of population declines on forest structure, over a range of scenarios.

The Conservation and Ecology of the Red Langur (*Presbytis rubicunda*) in Sabangau Tropical Peat-Swamp Forest

David A. Ehlers Smith (United Kingdom)
OuTROP / Oxford University, MSc candidate.

Sabangau tropical peat-swamp forest in Central Kalimantan constitutes one of the largest remaining contiguous lowland forest-block on Borneo. In October, 2009, I began to investigate the ecological requirements of the red langur (*Presbytis rubicunda*), an Asian colobine monkey endemic to Borneo. I sought to establish the ecological parameters vital to informing conservation strategies for the species, as relatively few published articles were available on the red langur. Between October 2009 and March 2010, I conducted transect surveys to calculate population density in the mixed-swamp forest, one of Sabangau's three main habitat types. Using the sampling principles of Distance, I discovered that the population in this habitat type occurred at relatively very high densities, an unexpected result given that peat swamps is often considered one of low biodiversity and densities due to the nutrient-poor environment. I began habituating four groups in the core study area, and subsequently recorded the behavioural, feeding and ranging habits through focal-animal sampling of three adult females in a mixed-sex group over one complete year (January – December 2011). In between I conducted additional population density surveys in the tall-interior forest and low-pole forest, the other of Sabangau's major habitat types.

Satellite Tracking, Social Behaviour and Management of the Bornean Elephant in Sabah, Malaysia

Nurzhafarina Othman (Malaysia)
Danau Girang Field Centre / Cardiff University - Sabah Wildlife Department.

In this study, I look at the social behavior, social organization and movement of the Bornean elephant (*Elephas maximus borneensis*) in Lower Kinabatangan Wildlife Sanctuary (LKWS). I will follow several family groups for two weeks every month. I will be tracking the elephants using GPS/satellite telemetry to establish knowledge about the dispersal range and social organization. I started my work in 2010 and plan to complete it within seven years as I am registered as a part-time PhD student at Cardiff University, UK. I hope that the results of this study will provide valuable information to the Sabah Wildlife Department for the future management of the species.

Human-crocodile Conflict: Increasing Understanding through use of Satellite Tracking, Education and Management

Luke Evans (United Kingdom)
Danau Girang Field Centre / Cardiff University - Sabah Wildlife Department.

The encroachment of humans into areas that were previously considered as wild has brought crocodiles and humans into constant contact. My study deals with the problem of human-crocodile conflict. The project focuses on the estuarine crocodile (*Crocodylus porosus*) across the state of Sabah. The aim is to discover adult crocodile ranges and long-term movements to assess when people are at the greatest risk of attack. Satellite tracking allows for unprecedented levels of information about this secretive and notoriously illusive species. As part of my study I will also examine how nesting behaviour has been affected by increasing human settlement. Smaller individuals are caught and tissue samples removed to develop an understanding of the genetic health of the species throughout the state of Sabah. The culmination of the project will result in the distribution of information to local people as well as a more detailed understanding of the standing of a species, which just 30 years ago was considered endangered. This work began in January 2012 and should be concluded by 2015.

Fragment Size, Edge effects, and Anthropogenic Factors influences on the Movement, Distribution and Parasite load of Proboscis Monkeys (*Nasalis larvatus*) in the Kinabatangan Floodplain, Sabah

Danica Stark (Canada)
Danau Girang Field Centre / Cardiff University - Sabah Wildlife Department.

Proboscis monkeys live in riparian, mangrove and swamp forest, which are amongst the most threatened habitats in Borneo. Due to the conversion of land along the Kinabatangan River, mainly for agricultural purposes, there are sites along the river where remaining forest may be insufficient for the requirements of proboscis monkeys. The impact of the size and shape of forest patches, as well as the types of forest edges may have an important impact on the intensity of use, and the distribution and movement of groups throughout the Kinabatangan region. By fitting proboscis monkeys with satellite collars throughout the course of my PhD, I will be able to quantify their daily and seasonal movement patterns for the first time, and examine which factors determine their movement and distribution. The intensity in which proboscis monkeys use their range will be examined through gastro-intestinal parasites found in faeces. The outputs of this project include a model to report on the effective conservation development of the Wildlife Sanctuary, and to identify useful corridor options.

This will be taken to national government officials as support in the restoration of wildlife corridors along large rivers in Sabah during an international workshop on the conservation of the proboscis monkey that we will organize at the end of the project in Kota Kinabalu, Sabah. This part-time PhD began with Cardiff University in 2012 and is expected to be completed in 2017.

Conservation Genetics of the Proboscis Monkey (*Nasalis larvatus*) in Sabah

Dr Senthilvel Nathan (Malaysia)
Danau Girang Field Centre / Cardiff University - Sabah Wildlife Department.

The proboscis monkey is an endemic species of the island of Borneo. Although movement and dispersal of proboscis monkeys are not restricted by water, populations become isolated due to the increasing loss of habitat by logging and agriculture (palm oil plantations). In 2005, an extensive survey in Sabah was conducted to establish the population status and to assess the threats to the survival of the species in the state. We estimated the population size to a minimum of 5,907 individuals found along major coastal river systems in Sabah. The distribution of the proboscis monkeys appeared highly fragmented, with only five major centres of continuous distribution and numerous small isolated populations. Only 15.3% of the population estimated was found within protected forest reserves, with much of the species' diminishing range habitats exposed to further conversion, extraction and disturbance leading to increased isolation of proboscis monkey groups. I propose to investigate how landscape and environmental factors can influence gene flow within and between populations in order to design adequate conservation measures for a highly endangered species of mammal. To address this, I will use two types of genetic markers, mitochondrial DNA and microsatellites.

Population ecology, demography and home range size of *Bos javanicus lowi* using an integrative approach of satellite telemetry, remote camera trapping and molecular analysis

Penny Gardner (United Kingdom)
Danau Girang Field Centre / Cardiff University - Sabah Wildlife Department.

I am studying the rare and endangered *Bos javanicus lowi* (common name: Banteng or Tembadau); a wild bovid on the island of Borneo. I started my PhD in 2010 (collaboration between Danau Girang Field Centre, Cardiff University (Wales) and the Sabah Wildlife Department) studying the population ecology, demography and home range of Sabah's banteng using a multidisciplinary approach, incorporating remote camera traps, noninvasive molecular genetics and GPS-satellite telemetry. In 2011 and 2012 I was able to collect the first baseline data of banteng in Sabah using camera traps, and have successfully located herds, created profiles for recognizable individuals, identified breeding status and activity patterns. By having a familiarity of banteng locations I was able to collect fresh dung samples for molecular analysis; I will use mitochondrial and micro satellite DNA to estimate sex-bias dispersal and kinship, and identify if sex-bias dispersal corresponds with spatial distribution. I am due to complete my PhD (2014) and hope to catch a subset of individuals and collar them with GPS-satellite tracking devices to identify their movements and estimate home range size. I also hope to identify environmental factors influencing habitat use such as vegetation structure, temperature and the effect of human presence. In the long term, I hope to raise the conservation profile, awareness and understanding of banteng, and contribute to the creation of a conservation management plan. And encourage young scientists to develop their own research ideas and undertake more challenging projects on species that are poorly understood.

Feedbacks between fire, vegetation, and landscape configuration: Peat swamp forest dynamics in the changing tropical landscape

Megan Cattau (USA)
Department of Ecology, Evolution, and Environmental Biology, Columbia University, USA.

In their natural condition, peat lands buffer saltwater intrusion, prevent flooding problems downstream, and have a large capacity for below ground carbon storage and, thus, a high potential to mitigate global climate change. Tropical peat fires can cause elevated human mortality, massive carbon emissions, and the loss of forest cover that is habitat for a rich array of flora and fauna. Fire can also cause dramatic changes to landscapes affecting both the composition and structure of the vegetative community and the landscape configuration of land cover types. Positive (amplifying) feedbacks can develop between land cover and fire.

In my research, I use remotely sensed data, field-based measurements, and modeling to evaluate the cause of fire events and the consequences for the forest community in a peat swamp forest. The study site is a former agricultural project in Central Kalimantan called the Mega Rice Project (MRP), the goal of which was to convert over a million hectares of intact peat swamp forest into rice paddies. The project was abandoned, but the remaining irrigation canals continue to causing peat soil drainage and subsidence, leaving the area susceptible to fire, a novel disturbance regime. With my research, I propose three specific aims. First, I will disentangle the relative effects of human access, vegetation and fuel load, fire history, and climate on fire risk by developing a Bayesian model of fire probability. Second, because fire alters the landscape configuration of forest fragments, I will assess the role of landscape configuration in structuring tree composition within forest fragments and the capacity for tree species traits to modify that relationship. Third, because in the absence of forest reestablishment, degraded peat lands will continue to become aerated, resulting in increased susceptibility to ignition and CO_2 emission, I will evaluate what factors alter the trajectory of vegetative regrowth in the post-burn barren area: establishment limitation from environmental filtering or seed limitation from altered landscape configuration. Understanding the underlying mechanisms of how disturbance affects ecological communities is a central goal of disturbance and community ecology, and my research will contribute to the body of work exploring the dynamics between vegetation and fire in the peat swamp forest. My work can also inform restoration efforts and land management planning on this complex landscape. The fieldwork for this project will be conducted during a 2013-2014 field campaign sponsored by the Fulbright Program, and the anticipated completion date for my dissertation is 2015.

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Use an ampersand (&) between author surnames when the citation is parenthetical: (Traeholt & Idris, 2011).

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Biography: This should describe the main research interests of all authors (<150 words total), apart from what is obvious from the subject of the manuscript and the authors' affiliations.

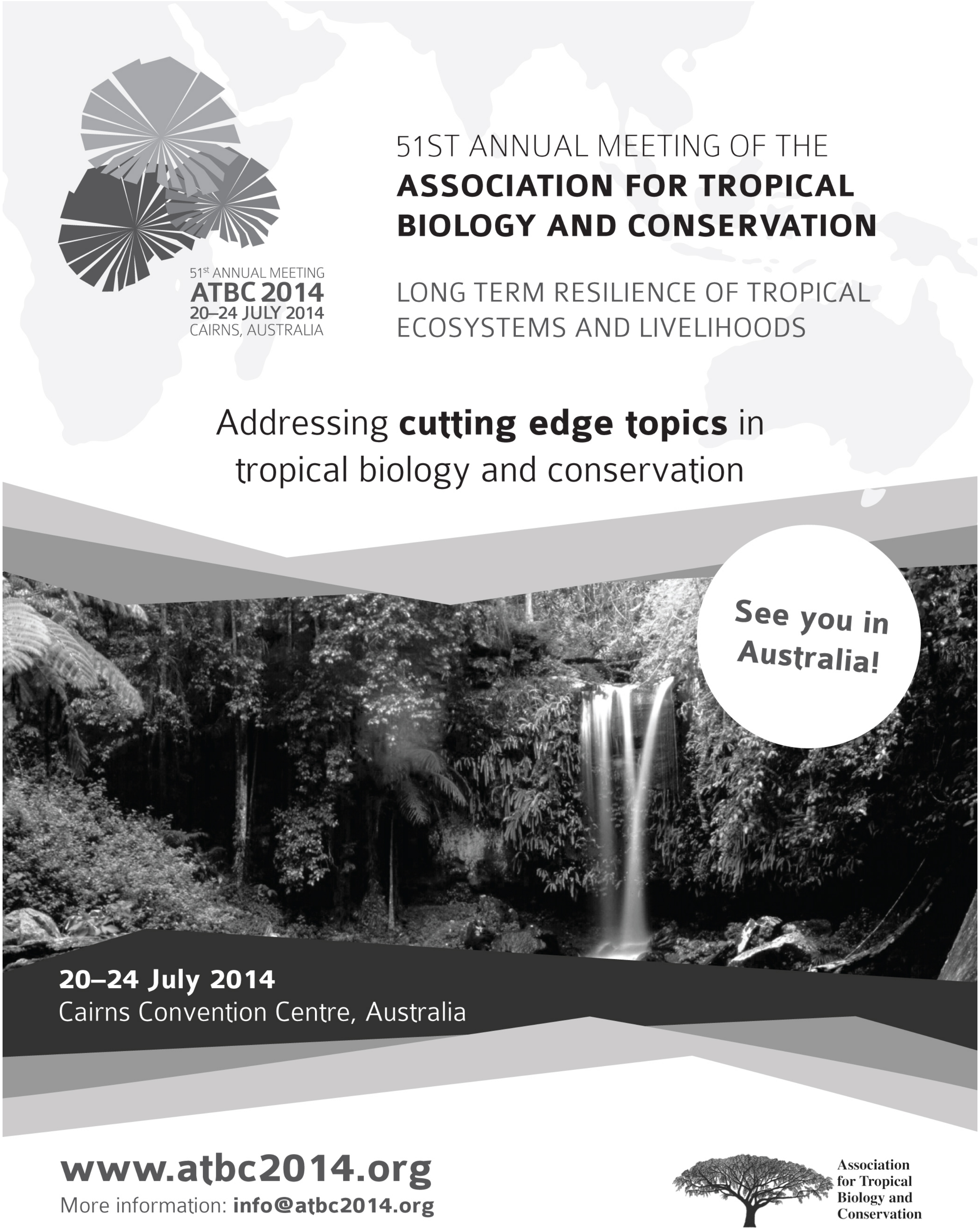
Tables, figures and plates: These should be self-explanatory, each on a separate page and with an appropriate caption. Figures can be submitted in colour as well as in black and white. The Editorial Team may decide to convert coloured figures into black and white should it be necessary due to printing cost and without diluting the message. Plates (black and white only) will only be included in an article if they form part of evidence that is integral to the subject studied (e.g., a photograph of a rare species), if they are of good quality, and if they do not need to be printed in colour.

Appendices: Lengthy tables, and questionnaires are discouraged. In special circumstances these may be made available for viewing online.

Species names: The first time a species is mentioned, its scientific name should follow in parenthesis and in italics: e.g., Asian elephant (Elephas maximus). English names should be in lower case throughout except where they incorporate a proper name (e.g., Asian elephant, Cookson's wildebeest, long-billed vulture).

Abbreviations: Full expansion should be given at first mention in the text.

Units of measurement: Use metric units only for measurements of area, mass, height, etc.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