

Solomon Islands Ranger Skills Guide



Lukaftarem pipol, ples wetem laef blo animol

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Caring
For
People
Place &
Wildlife

Solomon Islands Ranger Skills Guide

A reference guide and training manual for
Protected Area Rangers in Solomon Islands

by

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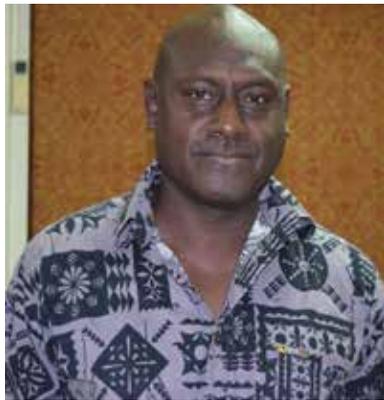
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In memory of



Tia Masolo

Deputy Director
Environment & Conservation Division
Ministry of Environment, Climate Change,
Disaster Management & Meteorology

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Foreword

Greetings Everyone!

Solomon Islands hosts some of the World's natural and unique ecosystems and species. Our coral reefs, our seas, our rivers and streams teem with abundance and diversity. Our peoples depend on nature and its resources for food, income and livelihood. With rich traditional and cultural knowledge, our peoples' wisdom in conservation of nature is not to be understated. Solomon Islands communities heavily depend on the wealth and health of our natural resources for our social and economic wellbeing.

Today, however, we face increasing economic and social challenges – growing population, rising food and fuel costs, etc – which place considerable pressure on our natural resources. For conservationists, environmental managers and practitioners, this is a major challenge and daunting responsibility – to protect the environment. Teamwork, knowledge, passion, experience and skills are paramount for the field of practice. For this, I am pleased to offer you this Ranger Skills Guide.

It is a challenge to create a Ranger Training Program and to bring rangers together to work as part of a united team, whilst at the same time building personal skill sets.

The development of this Guide is a first step in this process. The Guide focuses on training rangers in methods of data collection and monitoring skills. It is also essential in providing skills and information for them to think outside-the-box in terms of fundraising and attaining sustainability through alternative economic incentives. This Ranger Training Resource kit is intended to assist coordinators, practitioners and other groups or individuals who support grassroots environmental organizations interested in identifying ranger groups training needs.

Developing skills is fundamental, as it empowers community organizations to efficiently deliver outcomes that achieve a conservation and sustainable management goal. In delivering this training, there will be also an overview of the Protected Areas Act 2010, by which communities can legally protect and manage land and seascapes. This will assist rangers better understand the processes required and assist community organizations develop legal mechanisms for protection and management of the environment. Other legal frameworks

include the Forest & Timber Utilization Act 1969 and the Fisheries Management Act 2015 that can empower communities to manage their resources and monitor activities on the ground.

As a first ranger training guide, it will help the developers gauge which specific trainings are required for the future, when and where training can be delivered particularly at community level. By initiating and developing this program with the collaboration of the Solomon Islands National University, non-government organizations, universities, and partner organizations, and most importantly with input from rangers and community organizations; it can become a regular and essential aspect of community development and planning. It is imperative to involve communities and rangers at the outset, as this embeds ownership of the training program and may encourage them to further contribute to the training.

This document also provides useful reference materials to upgrade specific ranger proficiencies, and general information on how to apply them in the field. Furthermore, it does not demand nor set out skills competencies required to receive a University quality qualification.

To Rangers and Practitioners, I hope you find this resource guide useful, easy-to-use to enable you, your stakeholders and your target audience improve the ranger field of practice and know-how.

Finally, I wish to commend the outstanding expertise and commitment by the University of Queensland/CEPF Project team, in collaboration with Solomon Islands Community Conservation Partnership and Ecological Solutions Solomon Islands, in framing this first-ever Ranger Skills Guide. My Division looks forward to working and learning from you on the outcomes of the training program. Keep up the excellent work!

Let us all work together to ensure “A safe, sustainable and resilient environment for Solomon Islands” Tangio tumas!!

.....

Joe Horokou

Director – Environment & Conservation Division
Ministry of Environment, Climate Change, Disaster
Management & Meteorology





Stevens ground dove captured during a biodiversity assessment of forest and protected areas. The samples let us know whether the species is in decline or stable. It also shows us what habitats these species are found, whether primary forests, or secondary forest, or both. In which case this species is a forest generalist.



Acknowledgment

The concept of an Ranger Skills Guide course was introduced in 2015, as a way of bringing together rangers from across the Solomon Islands to a central venue, so that a course delivering specific knowledge and skill sets could be offered. The University of Queensland, in collaboration with the Solomon Islands Government Ministry of Environment, Conservation, Meteorology and Disaster Management (MECMDM), Solomon Islands National University (SINU), Solomon Islands Community Conservation Partnership (SICCP), and Ecological Solutions - Solomon Islands (ESSI) developed the training program, which was then field-tested in October 2015, and in subsequent trainings in 2016. The funding provided to set up this training program was made possible by the Critical Ecosystem Partnership Fund, and Wildlife Conservation Society (Pacific Programs).

For a long time, community organizations, research institutions, and the national government had been working independent of each other, in terms of collecting data, analyzing data and reporting findings to communities and to the government. Comparing findings across a sweep of community sites and local conservation organizations have been problematic due to the lack of data collection standardization, and communication between organizations.

The initial training participants come from an informal network of CEPF investment sites, and other enthusiastic community organizations throughout the Solomon Islands. This also comprises the inclusion of women rangers, who are integral to village verve, and who are also major users of natural resources in the community.

We thank the partner organizations, and rangers, and technical people who contributed towards this skills guide.



Chapter 1. Introduction

This guide is intended to help rangers or protected area managers in the Solomon Islands, to foster individual or group skill sets that will help them in their work. Various skills will aid rangers accomplish particular environmental outcomes, and produce improved and cohesive services that will benefit communities and the environment.

The park (or protected area) rangers have many roles, and this depends on the areas that they manage, whether on a small island, an area on a large island, or at sea. In general a ranger's responsibility can include a couple of things; conservation and protection of land or seascape and wildlife, managing recreation or guided tours for tourism operations, or assisting organizations by providing data that will help them plan and manage operations, including fundraising.

The Role of a Ranger

The most commonly known role of a ranger is to support the conservation of a species or a specified area. This includes:

- Safeguarding the protected area, enhancing and managing its natural and cultural resources
- Recognizing weeds and pest animals, and removing or controlling those that threatening the native plants and wildlife.
- Assisting visiting scientists and researchers that conduct biodiversity or social surveys related to the management of the park or protected area
- Promoting and maintaining cultural assets such as tabu sites, old village sites that are of cultural importance
- Advancing co-operative relationships with local indigenous communities, as social investment and associations can determine the success or demise of protected areas given the land tenure system in Solomon Islands.
- Assisting scientists to specifically identify and protect populations of threatened or endangered animals. For example leather back turtles. But this can also extend to other species of animals.



A ranger from Tetepare giving a talk to a visiting community. It is the responsibility of a ranger to advocate an understanding and appreciation for the natural and cultural aspects of the protected area. They are to supervise visits, and educate visitors about the rules and sometimes traditional do's and don'ts of the park.



- Maintaining forest tracks and accommodation huts, and other infrastructure of parks such as benches etc.
- Issuing permits to visiting researchers carrying out studies within the protected area. Some protected areas are associated with ecotourism operations, in which case the protected area ranger has an important role ensuring the following:
 - Visitor facilities including picnic areas, camping areas, and restroom amenities (toilets) are maintained
 - Maintain trails for hikers and other visitors
 - Answer emergency situations such as search and rescue. Hence the ranger must have first aid experience
 - Administer and manage staff, volunteers or students doing fieldwork or work experience
 - Deliver awareness talks, (interpret important information to non-English speaking communities that own and help manage protected areas), provide guided tours
 - Assist in the planning and implementation of various aspects of the projects, programs and deliverables.

Beyond just being a ranger, sometimes operating in remote situations, the broader and perhaps just as significant role of a ranger involves extensive planning, proposing of ideas, researching, strategic thinking, and human resource development and management. This is important to efficiently balance the conservation outcomes required to maintain the ecosystem functions of the protected area, whilst meeting recreation and economic incentives that come with a place, which communities may benefit from.

A ranger, if you like, can be seen as a guardian of particular place. Hence to fully function as a guardian, ranger skills and learning must be incremental, and upgraded over time. The obligations set out in a contract of a ranger needs to be met. The list of requirements are then developed into a ranger work and training plan.

This book covers the skills that are required by rangers to survey and monitor terrestrial ecosystems in the Solomon Islands, and is a companion book of ‘Solomon Islands Forest Life’. It is a resource for the new Solomon Islands Rangers Association and any local environment organization operating in the country. The ranger skills manual is a first step in the direction to provide training for rangers and the tools and skills required to work efficiently to fulfill their obligations, and provide data that may influence policy at the national level.



Scientific collaboration between overseas scientists and local Solomon Islands scientists and rangers is an important part of capacity building and skill sharing. Collaborative partnerships in biodiversity research offers various views and experiences that can be shared which can then be integrated into management plans for protected area systems.





Chapter 2. Conservation A Solomon Islands Context

There has been a steady increase in community-protected areas throughout the Solomon Islands. This has been generated mostly by the younger generation of islanders, demanding a more sustainable system of resource use and development. Simultaneously the main objectives of the Solomon Islands Protected Areas Act (2010) is to establish a system of protected areas (or areas where special measures need to be taken to conserve biological diversity), to promote environmentally sustainable development, and to rehabilitate and restore degraded ecosystems.

Conservation as it is defined in the western is to set aside large portions of land or sea for preservation or saving a species. This is often referred to as a rich man's idea in Melanesia. To reserve land for conservation purposes in Melanesia means that there needs to be well thought out, and maintainable alternative economic incentives. Due to the customary land tenure system in Melanesia (where most of the land is owned by traditional indigenous peoples), land or sea has always been utilized to sustain life. Whether in providing hunting or fishing grounds, or land to clear in order to plant a garden or plantation. Hence, conservation and the integration of protected area systems in Solomon Islands, need to cautiously consider how land is utilized, and how it may be best used to achieve a conservation outcome, whilst at the same time sustaining the life and livelihoods of indigenous communities who depend on the same resources.

Conservation and protected areas defined in this course, is a shift from the traditional concept, to favour protected areas as allowing responsible local resource use. Given the many benefits and challenges of sustaining protected areas (whether a marine park or terrestrial site), and the many drivers that daily influence its operation and existence, it can be difficult to measure its efficiency. Although one thing is certain, and that is protected areas on land or sea, are usually effective in restricting deforestation or overfishing inside their boundaries.

Community Conservation Agreements (CCAs) have been used in the Solomon Islands with varying success. A CCA is simply defined as “benefits for communities that will be provided by conservation investors in return for the protection or sustainable management of natural resources.”



Chapter 3. Survey Methods and Monitoring

There are many survey methods used for recording the presence of threatened species, understanding the dynamics of different species populations, or ecological communities within a protected area. Surveys are also useful for monitoring species, which occurs over a period of time. Sometimes a combination of methods is used to survey various taxa and aspects of the environment, such as vegetation, lichens, mosses, or wildlife. Standardizing survey methods across sites allows for data to be compared.

Ranger experience

Most Solomon Islands rangers already have impressive experience and knowledge of the bush. Some are able to identify different species of trees, or animals, distinguish similar species, recognize threatened species, and describe vegetation habitats. This traditional ecological knowledge (TEK) and familiarity with different taxonomic names of species are often acquired using local language names.

Defining the protected area

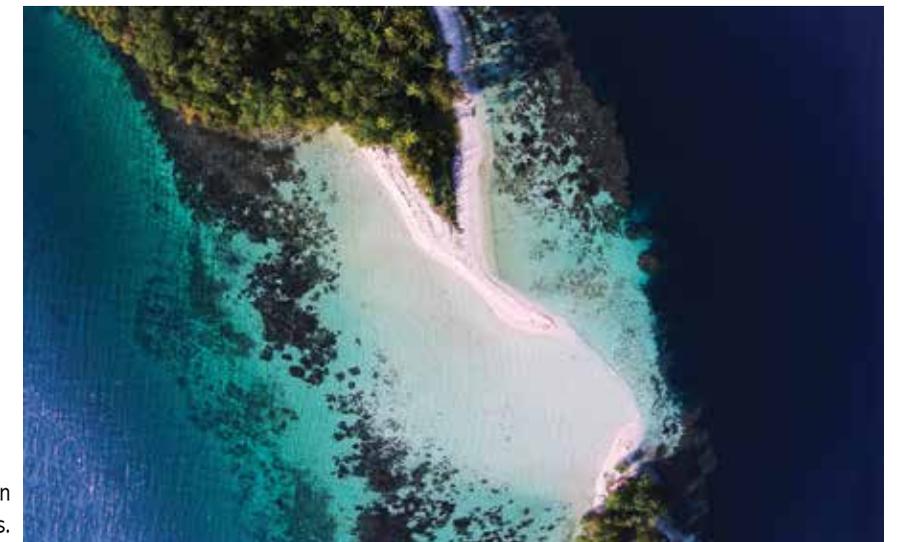
Understanding the protected area is the first step in managing and monitoring the systems that make it function. Accurately assessing the potential impacts that threaten the protected area is essential before beginning any field assessment. For terrestrial protected areas, vegetation data is needed for a number of reasons, and at various stages of detail. A general vegetation description gives a synopsis of the forest type, level of disturbance, floristic, etc. Data is generally collected in conjunction with faunal surveys for habitat identification and can be done in collaboration with visiting scientists, or government staff. Plants can be stored at the Honiara Botanical Garden Herbarium, which also records floristic, structural characteristics and other environmental data.

The protected area must be clearly defined, and marked on a map. History has shown that buffer areas are important to establish along clearly defined boundaries of protected areas for augmenting smaller reserves so as to increase their conservation value. Buffer zones also provide an additional gap between boundaries to alleviate the effects of deforestation that sometimes occur inside and outside parks, especially in very remote sites. There are benefits beyond protected area boundaries. For example, adjacent open areas receive a spill over of fish and trochus shells, in the case of marine protected areas, or birds and large vertebrates such as pigs from terrestrial protected areas. These natural resources benefit and support the livelihoods of local communities.

Enforcing protected area boundaries is costly and labor-intensive. Hence in demarcating and mapping protected area boundaries, workshops and collective participation of all community and tribe members is critical.

Habitat Assessment

Habitat assessments are recommended, as a complement of intensive surveys. During a habitat survey threatened species may be present given natural and intact forests. It is important to conduct a thorough habitat assessment across the entire site, identifying specific and general habitat characteristics. A surveyor should be familiar with the habitat requirements for different threatened species. Information from habitat assessments can be used in recovery plans, or to generate precise threatened species profiles. The quality of a habitat can be assessed through a number of indicators that give a general picture of the overall viability of an area, and its ability to support various fauna. The various processes for accessing habitat quality include mapping, field measurements, and simple calculations to



Typical coral island in the Solomon Islands.



Chapter 4. Forest and Vegetation Survey Methods

These methods are used to
conduct vegetation surveys and
habitat assessments in Solomon Islands

Introduction

To help us understand our Forest Areas (Ecosystems) and Forest Resources (Plants/Trees), we need to conduct a field assessment, inventory, stock-take, study, research or investigation out in the forest. This will allow us to collect and gather the relevant data we need for our community project records, reports and decision-making.

It is important to undertake a forest inventory and collect relevant data that can be used to monitor changes in land use that affect the forest and make decisions to plan, manage and conserve forest resources, for the present and future generations. Assessments of a given forest provide us with useful information relating to important timber trees, log volumes and their commercial values. Also information on endemic plant species, threats and conservation status, plant distribution, plant names and their various uses, may be obtained during as forest assessment.

Forest surveys mean measuring and describing the forest resources in an area. Sometimes this activity is also known as forest inventory, forest enumeration, vegetation sampling, forest ecological survey and timber sampling. It involves naming, counting, measuring and reporting types, sizes, abundance and other characteristics and special features of any forests and forest products in a sample area.

Forest sampling

Forest sampling, in a simple term refers to the act of assessing a small but representative part of a forest and using it to estimate the whole forest area. It can be done randomly or at

any selected sites, systematically in a pattern, on a grid or pre-selected lines and subjectively according to other criteria or unique features that may be chosen or preferred. However the most comprehensive method to evaluate the characteristics of a forest population is to carry out a thorough survey of each individual plant in the population. This method is both expensive and time consuming, and may even result in incorrect values when individual plants are arduous to identify. Hence the best method to obtain vegetation data for a population is to sample a small representative portion of that population, always keeping in mind that most vegetation populations are not uniform, and therefore samples must be obtained in such a manner as to represent the entire population accurately by using the methods described above.

Plan and Design of Sampling Plots

Forest sampling plots are normally planned, designed and implemented to meet the stakeholders' purposes (aims & objectives). They can either be Square Plots (Quadrats) eg: 10m x 10m plots, 20m x 20m, 25m x 25m, or 50m x 50m plots, etc. Transect (Line) 20m x 5m, 50m x 10m, etc. or Circular Plots with 10m radius, 15m radius, 20m radius, etc. It is important to consider the actual topography and landscaping of the forest area and make adjustments and corrections.



Rangers setting up vegetation plots, and taking measurements to determine plant species, and densities.



Forest and Vegetation Types in Solomon Islands

(a). Six Major Forest Types

The definition of what a “forest” is according to the UNFAO (United Nations Food and Agriculture Organization) is: as “an area of land covering more than 0.5 Hectares (Ha) with trees having stem diameters (DBH) of 10cm and upwards and reaching 5m and up in height.”

The natural forests of Solomon Islands are grouped into six major forest types, each of them having other specific forest community associations and examples that are determined by species compositions, canopy structures, soil types, topography, rainfall, water, temperatures, humidity, habitat localities and altitudinal range. They are as follows:

1. Coastal Forest or Beach Strand
2. Saline Swamp or Mangrove Forest
3. Freshwater Swamp, Marshes and Riverine Forest
4. Lowland Rainforest
5. Uphill and Ridge top Forest
6. Montane or Cloud Forest

(b). Eight Major Vegetation Types

The eight major types of vegetation recognized in the country are:

1. Coastal Strand Vegetation
2. Mangrove and Saline Swamp Forests
3. Freshwater Swamp Forests and Herbaceous Wetland Vegetation
4. Lowland Rainforests on Well-Drained Soil
5. Low-Diversity Rainforests
6. Seasonally Dry Forest and Grassland
7. Montane Rainforest
8. Anthropogenically Modified Vegetation

Tools & Equipment

Forest survey field equipment and tools or materials may include, but is not limited to the following: bush knives, measuring tape, diameter tape, measuring sticks, global positioning system (GPS) and map (if available), binoculars, camera, pen, pencil, papers, field note books, ropes, boundary markers/ribbons, plastics & newspapers for collecting plant samples for further identification, etc.

Common Forest types in Solomon Islands



1. Coastal Forest or Beach Strand.



2. Saline Swamp or Mangrove Forest.



3. Freshwater Swamp, Marshes and Riverine Forest.



4. Lowland Rainforest.



5. Uphill and Ridge top Forest.



6. Montane or Cloud Forest.



Plot Sampling

Plots of a standard size can, and may be used for vegetation communities. The plot delineates the area in which vegetation cover will be studied. Within the plot vegetation cover can be predicted, plants are counted, and a species list is made. Plots can be established randomly, systematically or subjectively inside the study site. In the rainforest some plants grow randomly in thickets and clumps. For this reason, narrow long plots generally contain more species, compared to square or round plots that are of equal area. Round plots may be more accurate as these have the smallest perimeter for a given area. Round plots are also easy to define in the field, necessitating only a center stake, and a tape measure to gauge out the length or radius.

The suitable size of a plot depends on what is to be measured. If the vegetation cover is the factor to be measured, then size is somewhat unimportant. If plant quantities per unit locale are to be determined then plot size is critical. The plot size should be large enough to comprise large numbers plant entities, but small enough to allow for plants to be separated, tallied, and assessed without replication. Sizable plots that contain main plants will entail two or more people to carry out the survey and attain an exact census. One person would be sufficient to survey a small plot with sparse vegetation.

Sampling Using Photographs

For very large areas, traditional sampling methods may be too labor intensive to provide accurate and reliable information. Therefore aerial photography using relatively large scale photographs (eg. 1:200) whether it be color or infrared photos is a more practical and efficient way to map out and even record individual plant species amongst a range of vegetation types. Satisfactory estimates of plant cover can be made using this sampling method, and even the condition of the soil can be acceptably evaluated. Grids overlaid over the photographs helps simplify the task of percentage cover estimates. The downside of using aerial photography is that the understory is usually difficult to observe and may be obscured by the upper canopy. In addition to this, photographs of an area must be evaluated before a significant amount of time passes, so that an accurate and up to date estimate of vegetation parameters is obtained from it. To obtain aerial photographs, hot air balloons may be used or even better, drones can be used which gives more control over the flight path and resultant photographs of an area that is to be sampled. However to obtain infrared photographs, special camera sensors are required and may be more expensive compared to conventional color photographs.

Monitoring Using Aerial Photographs

Aerial photographs of an area can be routinely taken from remote sensing devices such as satellites, air planes or drones. Remote sensing or aerial photography are practical over large tracts of vegetation, and also over a period of time to monitor changes in vegetation growth, type etc. There is specialized GIS software available such as ARC-GIS that allows in depth analysis and monitoring of vegetation using aerial photographs. Vegetation maps are illustrations of the spread of a plant community. Vegetation maps provide important information for environmental planning. Traditionally vegetation maps have been created by engineers with the knowledge of the vegetation in the area. However, nowadays with improvements in remote sensing using satellite imagery or other means of aerial photography whether from manned planes or unmanned aerial vehicles (UAV's) or drones, the task of vegetation mapping has been effectively made easier and also more efficient. Currently UAV's are well capable of identifying vegetation in an area, even down to the species level. Therefore in the future it is highly probably that vegetation mapping using UAV's is going to be the standard procedure, because of its efficiency in saving time, resources and man power.



Young biology graduates and learn aspects of data collection, and forest and riparian classification from a visit scientist from New Zealand. A rangers role is to assist and learn from visiting researchers, learning new skills of assessment, and applying new tools to assess the health and status of the forest.



Chapter 5. Reptile Survey Methods

These methods are frequently used to conduct reptile surveys in Solomon Islands

Introduction to reptiles of Solomon Islands

With 83 recorded, the Solomon Islands offers a rich array of reptile species throughout the country. Endemism is also high with the reptiles of the Solomon Islands. For example, at least 39 of the 83 reptilian species are found nowhere else in the world. These research methods aim to obtain data following standard methods for reptile studies. When dealing with reptiles a variety of sampling methods should be used to provide a greater comprehensive evaluation. These methods will target lizards and snakes. Geckos and most snakes are mostly active at night and skinks are mostly active during the day. The reptiles observed were identified to species level using Reptiles of the Solomon Islands (McCoy 2015) for reptiles.

Visual encounter surveys (VES)

Visual encounter surveys (VES) involves walking around and observing and identifying the different species of geckos and skinks in an area of habitat. Visual Encounter Surveys helps to determine species richness of an area, species assemblage of the area and relative abundances upon a certain time period expressed in person-hours. Four basic assumptions of the VES are; i) Every individual of every species has the same chance of being observed during a survey, ii) Each species is likely to be observed during each sampling session, iii) An individual is recorded only once in each survey, iv) results from two or more observers surveying the same area simultaneously are identical. Visual encounter surveys can take the form of transects, quadrats and randomized walk. Strengths of this technique are “hands on experience, the observation of cryptic species and juveniles” and this is a good efficient technique for sampling multiple species in “heterogeneous habitats”.

Transects

Transects can effectively track “species diversity, abundances and density”, this is a useful method for sampling along gradients and also within and across habitat types along a straight line with a fixed length and direction. Nocturnal geckos are best found by night time as they are more active then. With torchlight searching some species give off “eye-shine” and many are paralysed by the torch beam, making capture easier.

A recommended format for a VES transect would be a 500 m x 6 m belt. Begin sampling after sunset at 1900 hrs and cover a line transect in 1 hour with 2 people searching at a fixed effort of 2 man hours per transect.

Quadrats

Quadrat sampling involves the random placement of quadrats within a habitat to thoroughly search visually and by hand for herpetofauna. Quadrats can record species presence and absence, abundances and densities. This method is usually used for sampling in leaf litter and on stream sides where species densities can be high. Not only can this method collect daytime active animals but can also collect night time active animals that are resting.



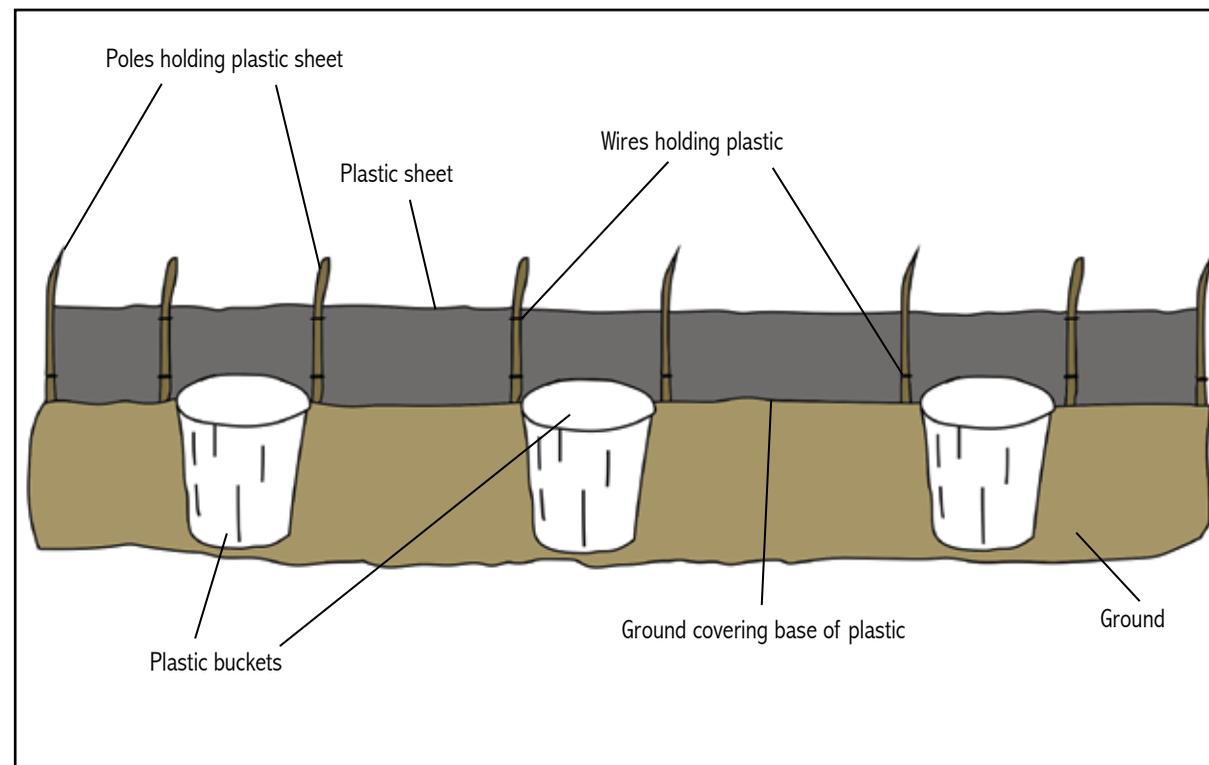
Crocodile skink caught from a randomized walk survey.



10 m² randomly placed quadrats were used at a fixed effort of 1 person-hour per quadrat or 2 persons sampling over 30 minutes. Randomization for the placement of the quadrats is carried out using the 'randomized walk' method where the observer uses pre-determined compass directions and distances for the placement of the quadrats. So beginning at a random location a randomized walk of a set distance and direction will lead to the placement of the north corner of the quadrat.

Randomized Walk

The randomized walk is used for rapid sampling where time and conditions do not allow for placement of quadrats or transects. The walk involves walking around in an area of interest over a recorded time, distance and recorded persons effort. It is important to record number of people searching, the duration of time and the distance covered so that a standard effort of person-hours and distance can be recorded. Randomized walks are useful to get a sense of the species composition of the site or area being surveyed. Also when making a checklist of reptiles a randomized walk may be used. Walking along a trail and search both sides of a trail for reptiles may be an easy way count species. In addition it is useful to veer off the trail



Schematic diagram of pitfall trap.

and cover areas that are not on the trail as some species may not found along disturbed path.

Sticky Traps

To help improve the accuracy of visual identifications and to increase the chance of capturing cryptic or shy reptiles, especially lizards, the use of glue or sticky traps may be used. Sticky boards are obtainable from survey suppliers. However, sticky boards to catch mice can also be used to collect fast moving lizards. Vegetable oil is then used to remove the lizards from the sticky traps. Traps should be placed in stations every 20m with 3 traps placed; 1 on the ground, 1 on a log and 1 on a tree. Replace traps when damaged or if lizards are collected on them.

Pitfall trapping

Other possible additional methods to help improve the accuracy of visual identifications and to increase the chance of capture for lizards especially the more cryptic species is the use of glue/sticky traps, cover-boards, funnel and pitfall traps with drift fences. Traps can capture more difficult species however different techniques are better for different taxa and a combination of methods are recommended to achieve maximum species detections. Pitfall traps when used with 'drift fencing' is a very effective method for detecting and catching both nocturnal and diurnal, non-arboreal reptile species that are active on the ground. Pitfall traps can be constructed by using PVC pipes, plastic buckets or any other non-gripping material that are dug, and buried into the ground, and which non-climbing reptiles cannot grip. The pitfall should be strategically placed in areas where reptiles frequent, or use as 'natural runs,' such as between boulders, among leaf litter, etc. A 'drift fence' can be constructed alongside



Example of a pitfall trap in the tropical rainforest. (Source: <http://people.whitman.edu/~jacksok/Expedition2006.html>)



the pitfalls to increase the 'taxonomic range' of the reptiles. The function of a drift fence is to effectively guide reptiles along it until they encounter and fall into the pitfall. Drift fences are a vertical barrier (~20-30cm high) constructed using plastic or other material (that non-climbing reptiles will find it difficult to climb), supported by steel pegs or wooden stakes driven into the ground. The lower edges should be buried into the ground on both sides, and all openings should be sealed by piling up soil. The pitfall traps when used with drift fences, should be constructed in the middle of the drift fence, so that any reptiles moving on both sides of the fence will fall into the trap. It is recommended to use 6 or more buckets (10L or larger in capacity) along a 15m drift fence. However variations in drift fence lengths and trap sizes and shapes to accommodate different sized species or individuals is also commendable. Square and rectangular shaped pitfalls are more recommendable compared with circular pitfalls, because they can extend out further (especially rectangular shaped pitfalls) on both sides of the drift fence. Rectangular and square pitfalls can also be compartmentalized along the middle, in line with the 'drift fence' above, to isolate captures on both sides of the drift fence. This is preferable when evaluating differences in biota, say along a habitat boundary.

Funnel trapping

Funnel trapping is very similar to pitfall trapping, and thus has similar advantages and disadvantages. Funnel traps require less time to install compared to pitfall traps, and are somewhat less destructive to the habitat. Like pitfall traps, observer bias is low, and relates only to the skill of the researcher to identify and properly handle the trapped individuals. There are many different types of funnel traps ranging from homemade mesh traps, to modified fish traps. However the basic design of the funnel trap consists of either a single end or double end opening that 'funnels' into the main compartment of the trap. Having

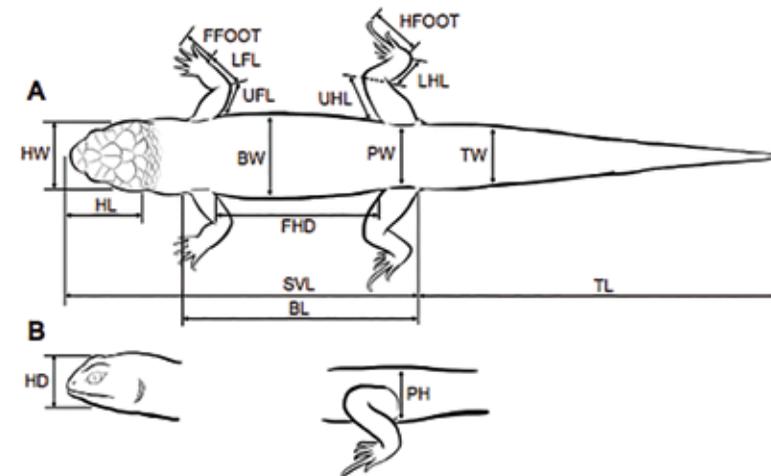


Funnel traps. (Source: <http://www.abc.net.au/news/2015-08-07/funnel-trap-pungalina/6680146>)

entered into the funnel trap, reptile(s) find it difficult to exit again, because of the smaller opening within and therefore they are effectively trapped. Using funnel traps can be advantageous in many ways. It is easy to conduct, and can be used for skinks and also both terrestrial and arboreal species of geckos, and to date is the only method for trapping arboreal geckos effectively without the risk of causing harm to trapped animals such as sticky traps might cause. Funnel trapping is also relatively non-destructive to the environment compared to pitfalls, and can be easily removed and relocated to other sites with ease, and thus mobility is also a big advantage of funnel trapping. The main disadvantage of funnel trapping is that the trapped animals are vulnerable prey for predators especially mammals (dogs, cats, rats etc.) which may either enter in or destroy the funnel traps to predate on the trapped animals. Therefore traps are only effective when mammals are negligible. It is also not recommendable to use for frogs, since frogs have a high probability of desiccating and drying out within the traps.

Simple morphological measurements of reptiles

External morphological measurements of live reptile specimens are also useful to understand ecological characteristics of individuals and species. Morphological measurements of reptiles especially skinks are useful to gauge population dynamics and health. Some common measurements that are taken of skinks include; Dorsal length (DL), Snout vent length (SVL), tail length (TL), tail width (TW), head length (HL), head width (HW), head depth (HD), body width (BW), body length (BL), pelvic width (PW), pelvis height (PH), fore-hind limb distance (FHD), upper foreleg length (UFL), lower foreleg length (LFL), forefoot length (FFOOT), upper hind leg length (UHL), lower hind leg length (LHL) and hind foot length (HFOOT) respectively.



Morphological measurements of reptiles (Diagram based on: Wu, N., et al. (2015). "Morphology and burrowing energetics of semi-fossorial skinks (*Liopholis* spp.)." *The Journal of Experimental Biology* 218: 2416-2426)



Chapter 6. Frog Survey Methods

These methods are frequently used to conduct frog surveys in Solomon Islands

Introduction to frogs of Solomon Islands

Frogs are one of the most abundant and diverse animals in the world with over 6400 species according to the American Museum of Natural History. Frogs are by far the biggest group in the class Amphibia which also includes other animals such as salamanders and caecilians. All amphibians are ectotherms meaning that they depend on their natural surroundings to regulate their internal body temperature. As a result most frog species are found in tropical and sub-tropical areas of the world.

Frogs have moist highly permeable skin thus most of them live in damp places to avoid their skin drying out. Having permeable skin allows frogs to exchange oxygen and moisture through their skin directly with their surrounding environment; or in other words frogs can literally 'breathe' through their skin. This unique feature means that frogs are closely dependant on their natural surroundings for their survival and wellbeing. Because of this, they are excellent bio-indicators of the health of an ecosystem meaning that they are usually one of the first organisms that will be affected if the natural environment is degraded.

Being geographically located relatively close to the biodiversity hotspots of Papua New Guinea and Australia; Solomon Islands are blessed with a high diversity of flora and fauna. To date Solomon Islands have 23 described native frog species with potentially many more undescribed ones. For comparison, Fiji has only 2 native frog species; Vanuatu and New Caledonia have no native frog species. Thus Solomon Islands has a more bio-diverse natural environment compared to many other pacific island countries of comparable size, which further emphasizes the need to sustainably manage and protect our natural environment.

Visual Encounter Surveys (VES)

Visual encounter surveys (VES) which are also known as nocturnal surveys, stream searches, headlamp searches etc, is basically a survey for adult frogs that is generally carried out during dusk, continuing into the night when the amphibians are most active. Diurnal habitat searches (searches during the daytime) can also be conducted however, diurnal surveys are known to be less effective compared to nocturnal searches (searching during the night). The reason for this is because most frog species hide away during the day and therefore more effort is required to look for them. Nocturnal searches should be carried out using either torchlight or headlamps to search for frogs, and is typically more successful on nights after rainfall.

Visual encounter surveys can be time dependent (time constrained searches) or area dependent (spatially constrained searches). Time constrained searches require the observer to search an area at constant speed and intensity over a predetermined time period. Spatially constrained searches require the observer to search out an area of known size (m²) with a defined method and intensity over a variable time period.

This is one of the most effective techniques for detecting and observing frogs which that



Using visual encounter surveys, two rangers search for frogs in forest floor.



are readily visible. VES offers many advantages, the most obvious being its usefulness in detecting some frog species outside of their breeding season when they are most abundant. However VES may not be effective for certain species of frogs such as tree canopy frogs or species that reside underground.

VES are usually conducted by field personal walking through known frog habitat such as near streams etc. and actively searching for exposed frogs or eye shine (reflection from frog eyes caused by shining a flashlight). Searching microhabitats within the larger general frog habitat is ideal for best results. If a specific frog habitat is a wetland for example, then the microhabitats within that particular wetland habitat would include; reeds and other shrubs along the shoreline, water plants such as water lilies, fallen logs, under rocks, etc.

All microhabitats in the general frog habitat should be searched, for optimum results. Therefore researches should search for frogs under fallen logs, amongst shrubs, under trees, under bark and leaf litter, along streams etc. However for specific frog species that are known to occupy a specific microhabitat (e.g. tree frogs usually live only in the tree canopy) it would be sensible to search for that target frog species only within their microhabitat (amongst the tree canopy) and not everywhere else.

Surveys conducted in rainforest or in other thick dense vegetation habitats may be more time consuming due to the increased complexity and structure of the habitat, therefore proper planning is required.

There are 3 common experimental designs for VES which are:

- Quadrant surveys.
- Transect surveys.



A ranger checking frog samples collected and placed in a plastic zip lock bag before data is collected.



- Randomised walking.

Quadrant and transect surveys are typically carried out to determine frog population densities within a particular area. Randomized walking is the usual VES method employed while trying to establish the diversity of frog species within an area. Randomized walking basically involves observers walking around at random and searching for frogs within a known frog habitat.

Transect Surveys

Transect surveys are a type of VES which involves setting out a transect line for example 100m, and then sampling for frogs 25m on each side of the transect line. Thus the total area sampled would be 100 x 50m (500m²).

Quadrant survey is another VES that is similar to transect surveys. Both transect and quadrant surveys are 'spatially constrained searches' meaning that both survey methods involve sampling a predefined area of known size (usually in m²).

Quadrant sampling differs from transect sampling in that it involves demarcating a quadrant say 50m x 50m, (300m²) and sampling for frogs within the quadrant. Quadrant sampling is more effective for smaller areas whereas transect surveys are typically used in larger areas.

Since transect and quadrant surveys both involve counting the number of frogs within an area of known size, frog population densities can easily be calculated and estimated (with a high degree of accuracy) for a particular area using either method.



Establishing a frog transect in the thick understorey of the rainforest.



Transect surveys involve:

- Walking along a transect line of predetermined length.
- Recording the number of frogs within a certain distance on both sides of the transect line.
- Preferred method to sample across microhabitats.

Acoustic Surveys

Acoustic surveys involve listening to and identifying male frog calls from different species. Adult males of most frog species use species specific calls during the breeding season as a way of attracting females and also to defend their territory against other males of the same species. Hence acoustic surveys or call surveys as they are also known as, exploit this habit. Acoustic surveys are very efficient compared to VES because calling male frogs can be heard even when they cannot be observed visually. Acoustic surveys are useful in identifying and also locating frogs that are hidden from visual observation because of the frogs: relatively small size, positioning, good camouflage, microhabitat use etc. Acoustic surveys are also suitable for surveying both terrestrial and arboreal frog species simultaneously.

Acoustic surveys also use recordings of male frog calls for later identification of the species, and also for playback in the field to attract female frogs of the same species, or to entice imminent replies from other male frogs. This is known as call playbacks. Call playbacks are advantageous in enticing out frogs that would otherwise be hidden from view. Frog calls are usually recorded using an audio recorder which can then be played back in the field.

Acoustic surveys can be carried out by:

- Static/point call surveys
 - Recording and listening to calls at a specific site without moving around.
- Audio strip transect
 - Recording and listening to frog calls along a transect line.
- Call playback
 - Enticing male frogs to reply to calls by playing audio recordings of other male frogs of the same species, and also to coax females out of hiding using the audio recordings.

However there are also limitations to this method such as:

- Usually only effective during the breeding season of each species or on nights following rain when there is increased frog activity.
- Some species or sub-species have very similar calls, and visual observation is

sometimes necessary to confirm the species identity.

- There can also be variation within call 'dialects' between species based on geographic location.
- Observers need to be able to identify each 'species specific call.'
- Call playback surveys may go unheard when used in areas of say, fast running streams where background noise may effectively drown out the recordings.
- Usually only adult male frogs are vocal, though females from some species are capable of making sounds as well.
- Frog calls decrease in intensity as the night progresses therefore it would be best to properly plan and then carry out acoustic surveys for optimum results.

How to Handle Frogs

If handling frogs is necessary, then the precautions listed below are to be observed and followed. However only handle frogs when absolutely necessary.

- Handling of frogs should be kept to a minimum so as to:
 - Avoid removing skin secretions
 - Reduce the risk of dehydration
 - Minimize the risks of pathogen transfer between individuals
- Apparatus and equipment that are to be used in the field such as: nets, bags, scalpels, callipers, mass balances, torches, headlamps, wetsuits, shoes etc. should be cleaned or sterilized thoroughly at the start of fieldwork, and also between field sites.
- A 'one bag, one frog' method for frog and tadpole handling should be the standard. Bags should not be reused.
- Researches using Passive Integrated Transponder (PIT) tagging or toe clipping, increases the risk of transmitting disease/pathogens directly into the frog's system, therefore proper sterilization of equipment's is essential.
- All of the above are precautions against the spread of frog pathogens such as the chytrid fungus.
- Do not use insect repellents, hand creams, sunscreen or any chemicals before handling frogs.
- Certain types of gloves such as latex and nitrile (synthetic latex gloves) can be lethal to tadpoles. Some gloves such as vinyl gloves are less lethal to tadpoles, and so if using gloves is necessary, care must be taken when choosing the type of glove for handling.



- Handle frogs in such a way as to minimize discomfort to the animals. Also it is recommendable to securely hold the hind legs of frogs (without hurting the animal) while handling them to prevent them from escaping.

Simple Morphological Measurements

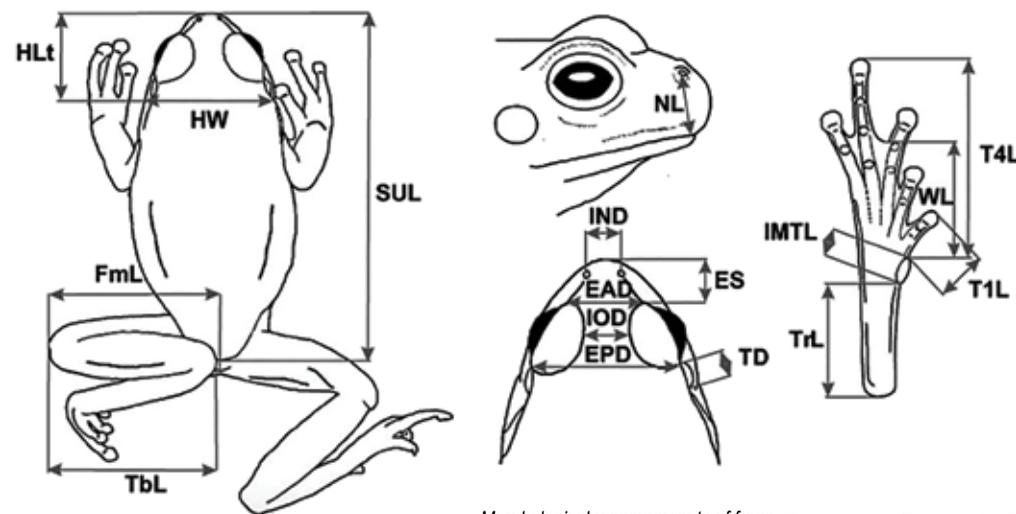
When handling frogs in the field, simple morphological measurements may be carried out for further identification and to record each species unique physical attributes. Listed below are the acronyms commonly associated with morphological measurements.

- SVL stands for 'Snout vent-length', which is from the tip of the snout to the end of the vent or urostyle.
- FML stands for 'femur length' which is the length from the middle of the cloacal gap to the end of the knee joint when the thighs are at right angles to body axis.
- TBL stands for 'tibia length' which is the length from the outside of the knee joint to the end of the heel.
- TrL stands for tarsus length which is the length from the outside of the heel to the inner met-atarsal tubercle.
- HW stands for 'head width', and is the largest width of the frogs head, usually measured from behind the eyes.
- HLt stands for 'head length' which is the length from the tip of the snout to the end of the tympanum (behind the eyes).
- ES stands for 'eye snout' distance which is the length from the tip of the snout to

the anterior of the eye.

- TD stands for 'horizontal tympanum diameter.'
- EAD is the distance between the anterior ends of the frog's eyes.
- IOD stands for 'interorbital distance' and is the shortest length between the upper eye lids of the frog.
- EPD is the distance between the posterior ends of the eyes.
- IND stands for 'internarial distance' and is the distance between the midpoints of each nos-tril.
- NL stands for 'nostril upper lip' and is the distance from the mid-point of the nostrils to the bottom end of the upper lip.
- IMTL stands for 'inner metatarsal tubercle length' and is the length of the base of the tuber-cle.
- T1l stands for 'first toe length' and is the distance from the edge of the inner metatarsal tu-bercle to the end of the first toe.
- T4l is the fourth toe length, and is measured the same way as the T1l above, but on the fourth (4th) toe.
- WL stands for 'webbing length' and is the length from the inner metatarsal tubercle to the tip of the webbing in the middle between the third and fourth toe.

Colour also varies amongst different frog species and within species as well. When recording morphological measurements note the colour type or describe colour variation of live specimens.



Morphological measurements of frogs. (Diagram based on: Gvozdk, V., et al. (2008). "Geographic morphological variation in parapatric Western Palearctic tree frogs, *Hyla arborea* and *Hyla savignyi*: are related species similarly affected by climatic conditions?" *Biological Journal of the Linnean Society* 95: 539-556.



Cornufer elegans, a common frog of forest understory's.

A large frog, *Cornufer guppyi*, in a specialize microhabitat.



Chapter 7. Bird Survey Methods

These methods are frequently used to survey for bird in Solomon Islands

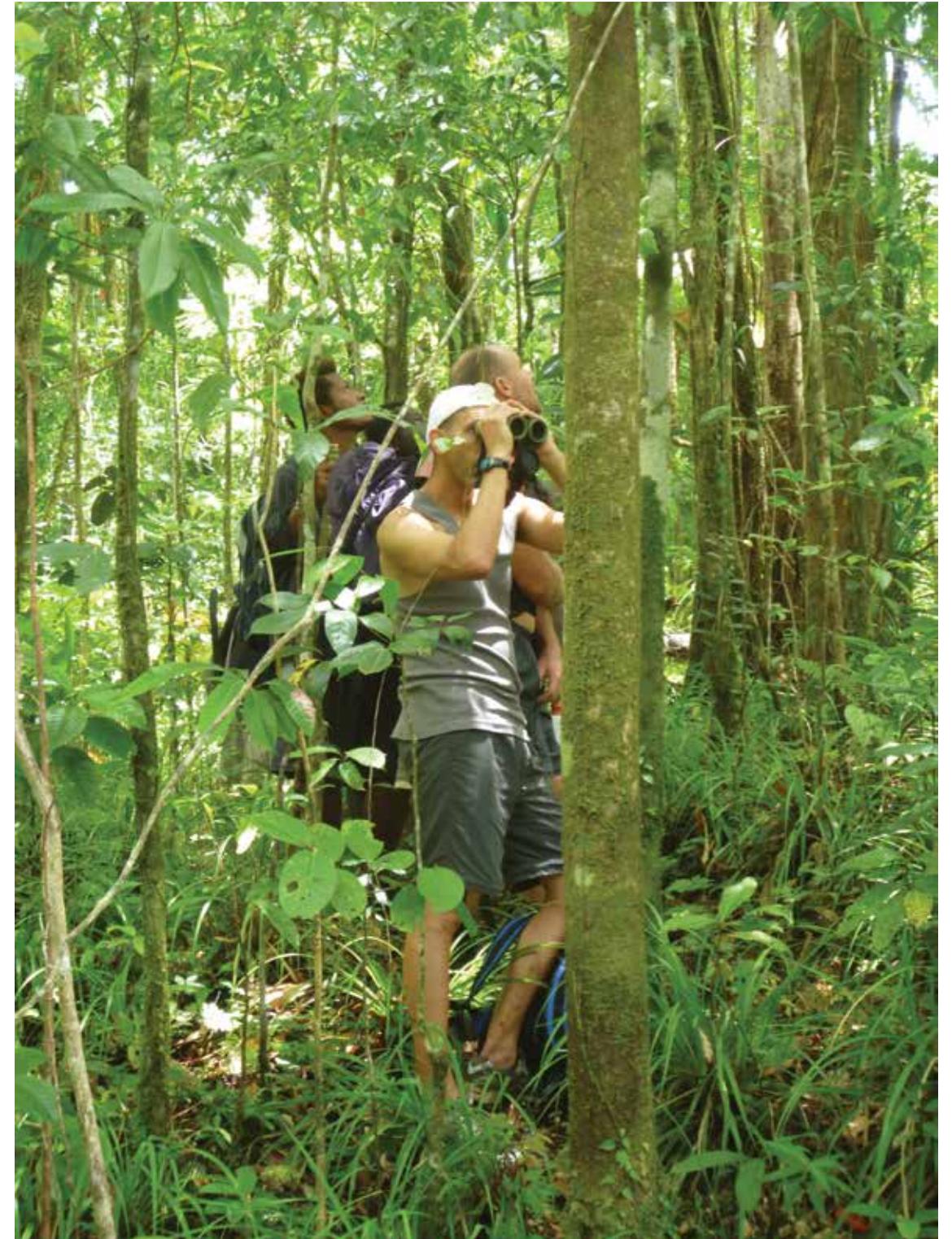
Introduction

Birds are usually brightly coloured, and highly vocal at different times of the year. Not all birds however, are brightly coloured. Some forest birds of the Solomon Islands are dark and dull, which makes them hard to spot in the rain forest. Birds are generally more popular than other taxa's and as a result, many colourful field guides are available, and there are many professional and amateurs with remarkable identification capabilities. Due to birds being popular they are amongst the most regularly studied of all the taxonomic groups in the Solomon Islands.

There are a number of different survey methods used to study bird populations and their movements. Each situation will require that a given method be marginally altered so that it is suited for local or species – specific use. Given the variety of methods available, we only focus on those that are suitable for tropical island environments, and have been used to survey birds in the Solomon Islands.

Area searches

This method consists of searching a defined area and recording data within the precincts of the defined search zone. The survey area can be small (500km²), or extend beyond that. The area is searched by walking a trail, or in some cases walking a route that is completely flexible. Area searches around an island may also including patrolling offshore on a boat and observing the coastline, or searching along the beach or on a trail along the coast and recording birds. The timing of the search must be recorded and consistent over the period of monitoring. For example, searches could take place in the morning for a period of 20 minutes or up to 2 hours, and at dusk for the same duration. It is important to be consistent with survey periods, if this is possible. There are formulas to adjust for uneven survey effort if the survey times are inconsistent.



Birdwatching in lowland forests in Solomon Islands. Listing is a simple way of recording which species is present in an area.



Listing method

Listing methods can be applied to a broad range of species and their habitats. This method is used widely in the tropics. Listing birds are often done by bird watchers, and is useful in rapid assessments within areas that are poorly known. This method can also be used to monitor bird populations.

Method

Birdwatchers make a list of birds that are seen in a specified geographic area. There will be common species occurring on a few lists, whilst rare species will make only a few lists. The frequency of occurrence for each species on any list is known as the 'reporting rate', and is a rough measure of relative abundance.

Birds can be monitored over time by comparing the frequency of occurrence at a number of counting stations, with an estimate of abundance from point counts at the same stations. Trends in species populations can be compared over time using this simple method. The greater the effort put into generating these species lists, the more comprehensive the list. Hence making comparisons with other sites may be problematic.

Equipment required

- Compass or GPS (Global positioning system)
- Topographic map of survey area
- Notebook, pencil and eraser
- Watch
- Field data sheets
- Plastic bag or zip lock bags to protect sheets from rain
- Field guides - Dutson, G. (2011). Birds of Melanesia, Helm Field Guides, UK. or Doughty, C., Day, N., Plant. A. (1999). Birds of the Solomons, Vanuatu and New Caledonia. United Kingdom, Helm Field Guides. Also checklists for more than 400 islands in Melanesia is available on the following website; thebirdsofmelanesia.org
- Binoculars
- Lens tissue or cleaning cloth to clean binocular lens and glass
- Flagging tape
- Audio recorder to record bird calls

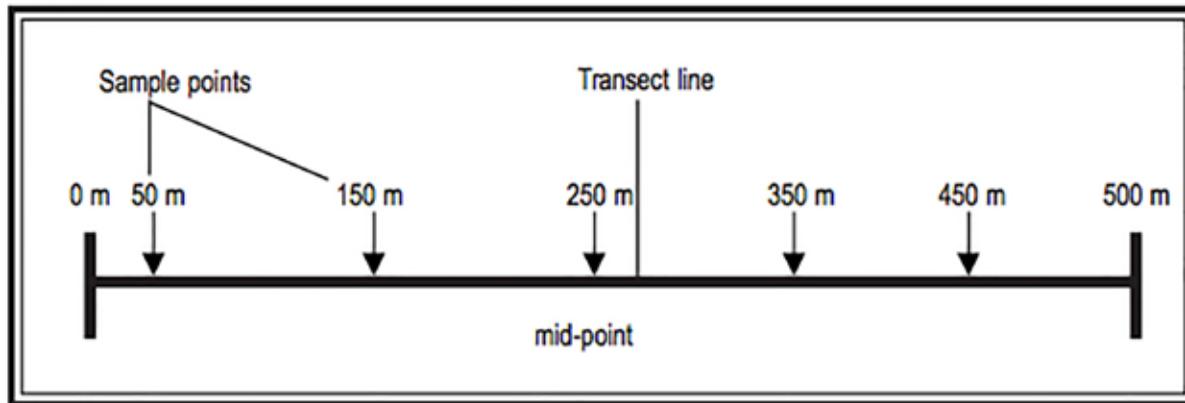


A ranger checking a field guide to identify birds.

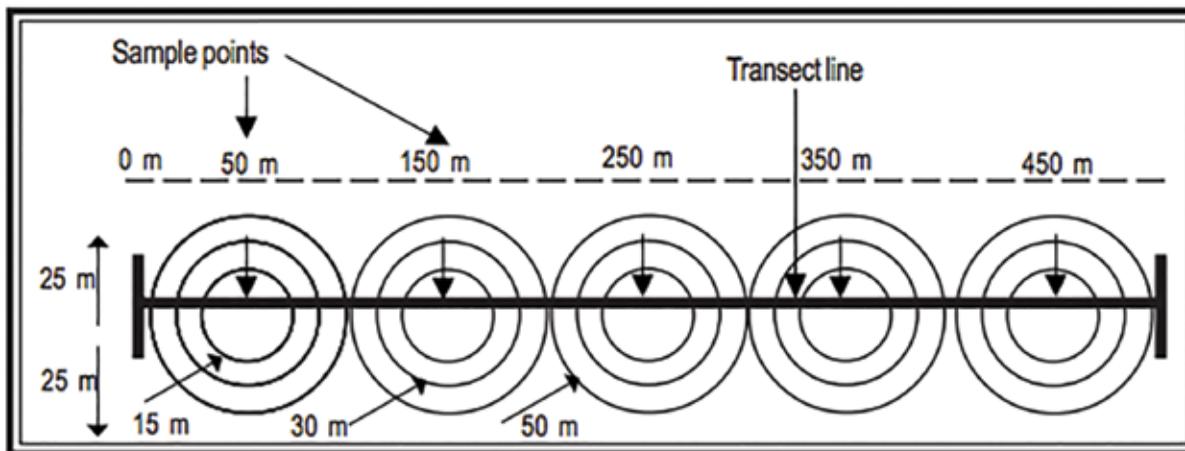


Participants of a survey checking a field guide to identify a captured bird.





Adapted from Bird Survey Methods, National Parks of New South Wales Inc.



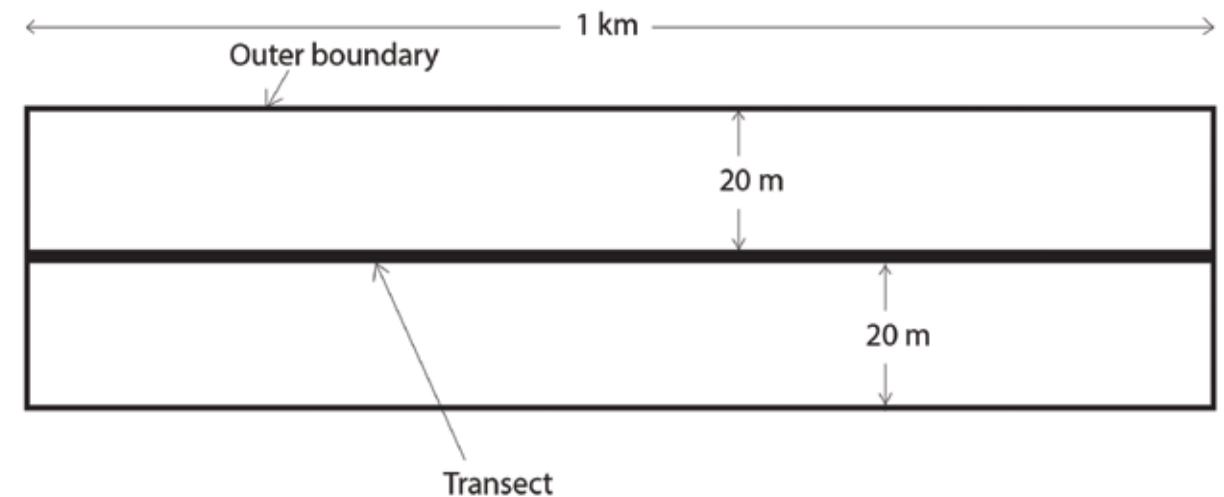
Adapted from Bird Survey Methods, National Parks of New South Wales Inc.

Composition of survey teams

The bird survey team should be comprised of a small group of up to four.

Transect Method

This involves the observer walking a straight line while recording the numbers and species of birds along the transect. During the survey the observer must not veer off the transect, and note all the birds. Transects are often marked with flagging tape, but not always. When surveying birds in the Solomon Islands, bird densities are relatively low compared to continents or larger islands such as New Guinea. To maximize the chances of observing birds, the transect should be as large as is possible. Furthermore, landscape also determines what kind of birds are seen. The landscape can vary with each site, and island. A transect is often visited twice a day (at dawn and dusk), or any time of choosing, and over a period of days. There are a couple of different bird transects that can be used. Both are outlined below.



Typical 1km transect design with 20m truncate line on both sides of the center.

Procedure outline

When setting up a 500 m transect, use flagging tape to establish the transect trail. Use the flagging tape and a GPS to mark the start of the transect and the end of the transect line. Between the start and the end of 500 m transect, mark clearly five points, which are evenly spaced at 100 m. The first point is located 50 m from the start of the transect, and subsequent points spaced 100 m apart.

A flagging tape should mark the spot at each sampling location along the transect. The sampling location, must also be provided a unique identification number that is then entered into the field data sheets. This can be assigned to the first column in the observations table.

At each sampling location on the transect, imaging a bullseye target. Around the sampling location measure out 15 m circumference and flag. Do the same from 15 - 30 m, and 30 - 50 m, and flag both circumference. Preferably with different coloured flagging tape to colour code the distance. The birds that are outside the bullseye however within the same representative habitat may be recorded opportunistically.

A simpler transect setup requires a person to walk a distance of 1km. The 1km transect then has a 20 m distance on both sides that is flagged. Birds are observed within the transect boundary. Birds recorded outside the transect boundary may be recorded opportunistically. You can adjust the transect length, depending on the number of birds encountered. Depending on the landscape certain transects may have to be lengthened or shortened. If there are not enough birds encountered on a 1km transect, it is suggested that another separate transect is established rather than extending a transect more than a 1km. It is important to



keep the length as well as the truncate distance from the center line and the same along the entire length of the transect.

It will take at least 30 minutes to walk each 1km transect. Although 20 m truncate is standard transects 1km long, you can use differing lengths and widths. The important thing to keep in mind is to be consistent. There are different ways for accounting for different width and transect distances, when making comparisons across various sites.

Time of survey

Together with survey area, the time required to walk a transect must be consistent. Generally 30 minutes could be given to walk a 1km transect. If during trials this is not enough and not many birds are recorded then the timing can be adjusted to perhaps 40 minutes. This may be the case on small oceanic islands, where birds densities can be low. It is essential that enough time is given to be able to record species and count the numbers of birds observed. When there is consistent effort (time) given to surveying each transect, then it avoids the biasness of recording more birds on a transect where more time was spent. If you need to take a break or record data during the transect survey, do not record any birds at this time.

When conducting monitoring at least 1 to 3 transects a month need to be done. More



transects the better. Any month of the year could be surveyed, however, it is suggested a survey in the Solomon Islands wet season and another during the dry season. Surveys can also be done at night to record nocturnal species such as owls. During the survey, record all the birds that are seen and heard inside the boundaries of the transect. Opportunistic recordings of birds may be done outside the transect.

Counting birds

When the transect is established, observers can start counting the number of birds of each species that are heard or are seen. It is important to note the number of people counting on the transect.

Mist Netting Method

Mist netting is a technique that is widely used for studying small and medium sized birds. The nets are made from fine nylon, terylene or polyester, that is weaved into a large net, and then suspended between two poles. The net is often positioned in the flight path of birds, for example across a ridge, or across a stream. These nets are small and easy to pack and transport, and have been used in the Solomon Islands to capture and study cryptic and rare birds. They have been confirmed successful in a number of habitats. Often the purpose for the use of mist nets are to band or tag birds. When captured the age, sex, and conditions of the bird is recorded, and morphometric measurements done, after which a leg band is placed on the animal before it is released. The handler is often certified, however, in the Solomon Islands, there is no certification processes, so the persons must be trained by a scientist, and must be well versed in the handling of birds.

Procedure outline

A location is first picked where the mist net is to be placed. Sometimes this has to be cleared. The position of the net, will also depend on the type of bird that is surveyed. Passerines and other birds of the canopy and mid-canopy will require that the net is placed high. For other forest birds, like ground pigeons such as the Santa Cruz ground dove (*Gallicolumba sanctaerucis*), or Thick-billed ground dove (*Gallicolumba salamonis*) and other kinds of forest floor birds, the net will need to be placed nearer to the ground. Success of mist netting will also depend on the density of birds as well as habitat characteristics at the study location. It is not ideal to hang the mist net where it is clearly visible, for example in a clear field, or on a beach where it is exposed and often windy. Wind can tangle the net, and may permanently damage it.



Setting up the mist net

1. At least two persons are required to set up a mist net. An experienced ornithologist may be able to set up a mist net by themselves, however, it is best, especially in tropical forests where there are vines and dense understory that two people are required to set up the net. First, clear the net path, and remove any obstructions between the two poles where the net will be suspended.
2. While removing the mist net from its bag, be careful to keep the net off the ground to avoid it getting tangled with vegetation or rocks, which might damage the net.
3. Arrange the string attachments on the mist net, and identify the top from the bottom. Most mist nets will have a string attachment loop that is different in color to differentiate the top from the bottom.
4. Obtain 2 poles and attach the string loops into position on the pole, bottom loop first. Poles can be made from trees of suitable size, cut down and stripped off their leaves and branches. Sharpen one end into a pointed tip; this is the end to be staked into the ground. Unroll and stretch out the mist net, being always cautious not to get the net tangled on the surrounding vegetation. It is also possible to set up multiple neighboring mist nets on the same pole. Setting up neighboring mist nets on the same pole requires the same procedure described above, however each mist net loop must be alternated with each other.
5. Bury the pointed pole ends into the ground and stabilize the poles by using secure lines with one end tied to the pole (preferably $\frac{3}{4}$ up the pole) and the other tied firmly to other fixed objects such as other trees, rocks, bushes, or stakes/pegs which have been driven into the ground.
6. Erected mist nets should have tight horizontal shelf strings, preferably with limited or no sagging as is possible. The tension of the mist net is dependable on the securing lines. Each 'pocket depth' within each 'shelf' is controlled by adjusting the lengths between the individual loops of the mist net.
7. Birds that are caught close to the ground are likely to injure themselves, and also cause damage to the net. Therefore it is recommendable to clear the area of branches or other

debris that might catch on the mist net to account for the birds struggling and moving the mist net around. For ground birds, setting the net at least 30cm above the ground or above the tallest shrubbery is recommended to avoid ants getting into the mist net and causing harm to the caught birds.

8. It is not recommended for the netting of birds over water, as this runs the risk of the birds drowning.
9. Care must be taken to check nets regularly, to avoid predators entering and destroying the mist nets. In public areas, pets such as dogs and cats should be kept away from the mist nets.



Local participants taught how to handle wildlife (birds) during a biodiversity survey. Collaboration during biodiversity surveys are important to help local rangers understand what occurs in the forest, and what species are unique. These surveys also give an estimate of a species population. The skills acquired help locals in understanding the ecology of the species, and it's relation to the forest, and adds to already known traditional ecological knowledge.



Chapter 8. Mammal Survey Methods

These methods are frequently used to survey for small mammals and bats in Solomon Islands

Introduction

Although highly diverse compared to other insular South Pacific countries, the Solomon Islands forest mammal fauna is still poorly known. Not many sites that have been extensively inventoried or are subject to long-term monitoring. This section discusses some methods for surveying mammals in the Solomon Islands.

Bats can be some of the most difficult animals to count due to their mobility. Large fruit bats as well as smaller Microchiroptera bats roost during the day and are active at night. Bats are captured using black 75 denier, 38mm mesh nylon mist nets (12m in length x 2.6m in height) (M. Nakamori & Co., Ltd., Yokkaichi, Japan). Nets are configured individually within forest understoreys on wooden poles up to X m from the ground. The number and configuration of nets used varies to suit the physical characteristics of each site. Nets are placed on tops of ridgelines or spanning watercourses to maximize the number of species and individuals captured. For the Solomon Islands, normally an average of 3.6 nets per survey (SD = 0.8, range= 2-6). Surveys commence at dusk and nets are checked every half hour until they are closed. Surveys are conducted regardless of temperature or whether or not precipitation is received. Survey effort is calculated as the net-m h-1, thus one 12 m net deployed for one hour gives an effort of 12 net-m hours.

Bats are surveyed using a combination of mist nets, harp traps, and Elliott traps. Normal mist nets (6–12 m long) are set in areas where concentrations of bats are expected (streams, trails, clearing edges, near fruiting trees). Harp traps are used in confined settings such as cave entrances and are particularly useful in sampling insectivorous bats that detect and avoid mist nets.

Nonvolant mammals or small mammals are captured primarily via snap traps set near burrows and along terrestrial runways or in canopy branches and vines. Snap traps are baited with peanut butter, coconut, or earthworms. Medium-sized species are sampled via



TOP: A field assistant setting up an arboreal cage trap in a tree.
ABOVE: A Typical arboreal cage trap setup.



cage traps, supplemented by animals collected by local hunters. Live-trapping using cage traps are the most frequent method for assessing the abundance of many species. Recently the use of digital camera traps have been used to target rare and cryptic species, as well as assessing the extent of invasive species.

Collection Methods

Mist netting

Mist nets are fine nylon nets that are used by ornithologists as well as bat biologists to capture birds and bats. Mist nets are set up within areas where there is a likely chance of bats flying, for example a gap in the canopy or across stream sections. The net has shelves spawm by horizontal lines which make a sagging pocket. When a bat or a bird flies into the net it then falls into the pocket, and becomes tangled (see photo on page 54). Mist nets are only used by those that have been trained. This is a method used for collecting cryptic species, and for making checklists. A combination of mist netting and other survey methods such as bird counts may be used to ensure a comprehensive checklist is made. When assisting a scientist who is using a mist net to study birds, rangers should only wear a plain t-shirt, as buttons in a button-up shirt will get caught in the fine nylon net.

Elliot traps

At each systematic site, Elliot traps are set at regular intervals along the transect. Traps should be baited with a standard bait mixture (oats, peanut butter, honey and vanilla essence, or in the case of remote sites, just coconut) and set in place for four nights. The amount of bait should be sufficient to provide an adequate food resource for trapped animals.

Traps will be provided with bedding of either dry leaves or a non-absorbent fibre (for example, Dupont Hollowfilltm). If there is any risk of inclement weather, they should be covered with plastic to prevent rain entering the trap. Plastic bags should also be used for insulation where night time temperatures are very low. In order to prevent ant-related mortality, where ant activity is very high, insecticide may be sprayed around traps.

Arboreal traps are securely fastened to an arboreal platform that is firmly attached to the tree. Traps should be located on the southern side of the tree to reduce exposure to the sun.

Each Elliot trap should be clearly and sequentially numbered and set out in order. Flagging tape should be used to indicate the location of each trap. A second piece of flagging tape should be used to indicate the presence of a large Elliot trap (or other trap).



Carrying cage traps in the forest can be laborious and yield very little success. Terrestrial traps are often more successful than arboreal setups.



A small mammal caught in a cage trap.





TOP: Scientist and rangers clearing a mist net of bats.
 ABOVE RIGHT: Camera traps capture wild boar. Camera traps are useful in monitoring the extent of invasive species.
 ABOVE: Camera trap set in forest understory.

Cage Trap

Cage traps should be set at regular intervals along the transect for a period of four nights and their location clearly marked. The traps would be set with a combination of vegetarian and carnivorous baits.

Cage traps should be located where possible in sheltered locations to mitigate the potential impact to animal welfare as a result of exposure to the climatic elements. Each trap should be covered with a small blanket or similar piece of material. Cage traps (in particular) should be located away from paths or residences where people or dogs may come across trapped animals.

Traps should be cleared early each morning and checked during the day when possible. In very hot weather, traps should be regularly checked or closed during the day.

Snap Traps

The snap trap most common and effective way of trapping small mammals in Solomon Islands. However, these are always lethal and mostly effective for terrestrial mammals such as *Melomys*.

Spotlighting

Spotlighting involves two observers traversing a 500m transect with 50W spotlights or a strong torch for a minimum of two person hours per night on two separate nights, for a total of four person hours per site. Distance to individuals seen or heard would be recorded as on-site (if within 50m x 500m transect) or off-site (if outside the 50m x 500m transect). Spotlights should be fitted with dimmer switches or a red filter to limit the disturbance of animals.

Camera traps

Camera traps are useful for detecting shy and cryptic animals. They can be placed in the forest or grasslands, where ever a target species is located, bated and left for a couple of weeks to a couple of months. Any animal moving in front of the motion sensor will trigger the camera to take still or moving pictures depending on the camera settings. If using camera traps in the tropics ensure that the model is waterproof and it has a long battery life. The humidity and isolation of most sites, could mean they are not often checked, to have the footage downloaded and battery replaced.



Harp Trapping

Traps could be set opportunistically to target significant species such as the Golden-tipped bat (*Anthops ornatus*). Harp traps need to be checked within 2 hours of dusk and every morning. Harp traps may capture very large numbers of bats and in some cases may need to be checked and cleared during the night (e.g. when located near caves or other roost sites); Harp traps should be moved during the day where it is possible vehicles or members of the public will be using access tracks with harp traps on them; Birds may injure themselves flying into harp traps. During the day, harp traps should be turned sideways and / or the catch bag removed; Persons removing bats from harp traps should have had a course of lyssavirus vaccine shots and tetanus shots.

Ultrasonic Bat Detection

Ultrasonic bat detectors have been used for a couple of decades. These are used to identify free flying bats. The Anabat units with CF ZCAIM recorders can be set over at least two (2) nights at suitable locations at each systematic site, commencing at dusk. Recorded calls are analysed by bat call experts.

Anabat units must be protected from rain by placing them within plastic containers. They should not be used in situations where heavy rain is expected. Batteries should be changed daily if possible, or at least every second day.

Other collection Techniques

Local snares

Small mammal populations provide important sources of protein for some local communities. Some small mammals like rats are invasive and cause damage to food crops, hence need to be dealt with. To capture small animals local technologies are used, including local snares. These are some of the most effective ways of detecting small mammals, and are often lethal, and should be used only with supervision by an expert. On Choiseul Island, local snares have been used to trap the prehistorically introduced Spiny rat (*Rattus praetor*).

Pitfall traps

Pitfall traps are dug into the ground. The holes must be deep enough so that a PVC pipe or a bucket with smooth sides may be placed inside, and the gap between the hole and the trap filled. The bucket should be covered with a thin plank or with wide leaves to prevent rain from flooding them. There should be drainage holes at the base of the bucket. Our

experience is that these are not that successful for small mammals, as they are for ground skinks.

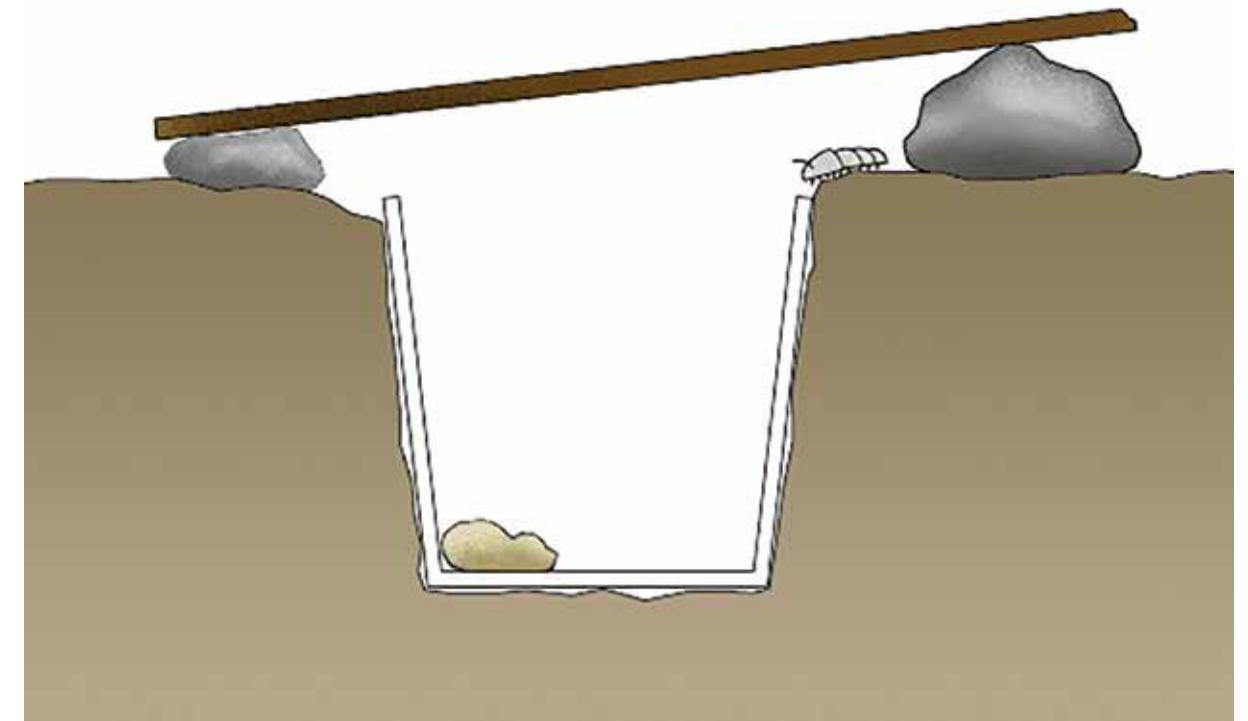
Live box traps are often checked twice a daily, in the morning and in the evening. It is suggested though that four checks a day is preferable to reduce the amount of stress on the animal. For some species, trapping at night should not be done. However, if traps are set open at night, regular night checks are needed. Pitfall traps need to be checked as often as it is feasible, because they are multiple-catch traps, and animals can injure each other from fighting.

Measuring Key Environmental Variables

Recording the environmental variables associated with the occurrence of mammals is important in testing different relationships.

Forest type

There are generally six forest types in the Solomon Islands. These include 1. Coastal forest, 2. Swamp or march forests, 3. Lowland forests, 4. Hill or ridge forests, and 6. Montane



Pitfall trap (Source. bbc)





TOP: Setting out mist net in montane cloud forest.
ABOVE: Taking GPS readings and vegetation descriptions.

cloud forests. It is important to get a record of the forest type for each survey site.

Vegetation Description

Gather a general description of the plant communities of the site. This could include a general list of the assemblages of plant species that dominate the understory, overstory and ground cover. The species of shrubs, etc. Taking photographs of the site, and individual photographs of the dominate plants is important. A botanist could then describe the vegetation of the area using photographic evidence.

Altitude

The elevation of the survey site can be recorded using an altimeter or a forest GPS. Make sure that the GPS is first calibrated at sea-level and is one that has a sensitive sensor that is able to take GPS readings under heavy canopy cover.

Other variables

The more variables recorded, the better the level of associated environmental correlates that can be assessed. However, this will depend on the questions needed to be answered.



Chapter 9. Freshwater Fish Survey Methods

A brief guide based on the freshwater survey work in Solomon Islands

Introduction

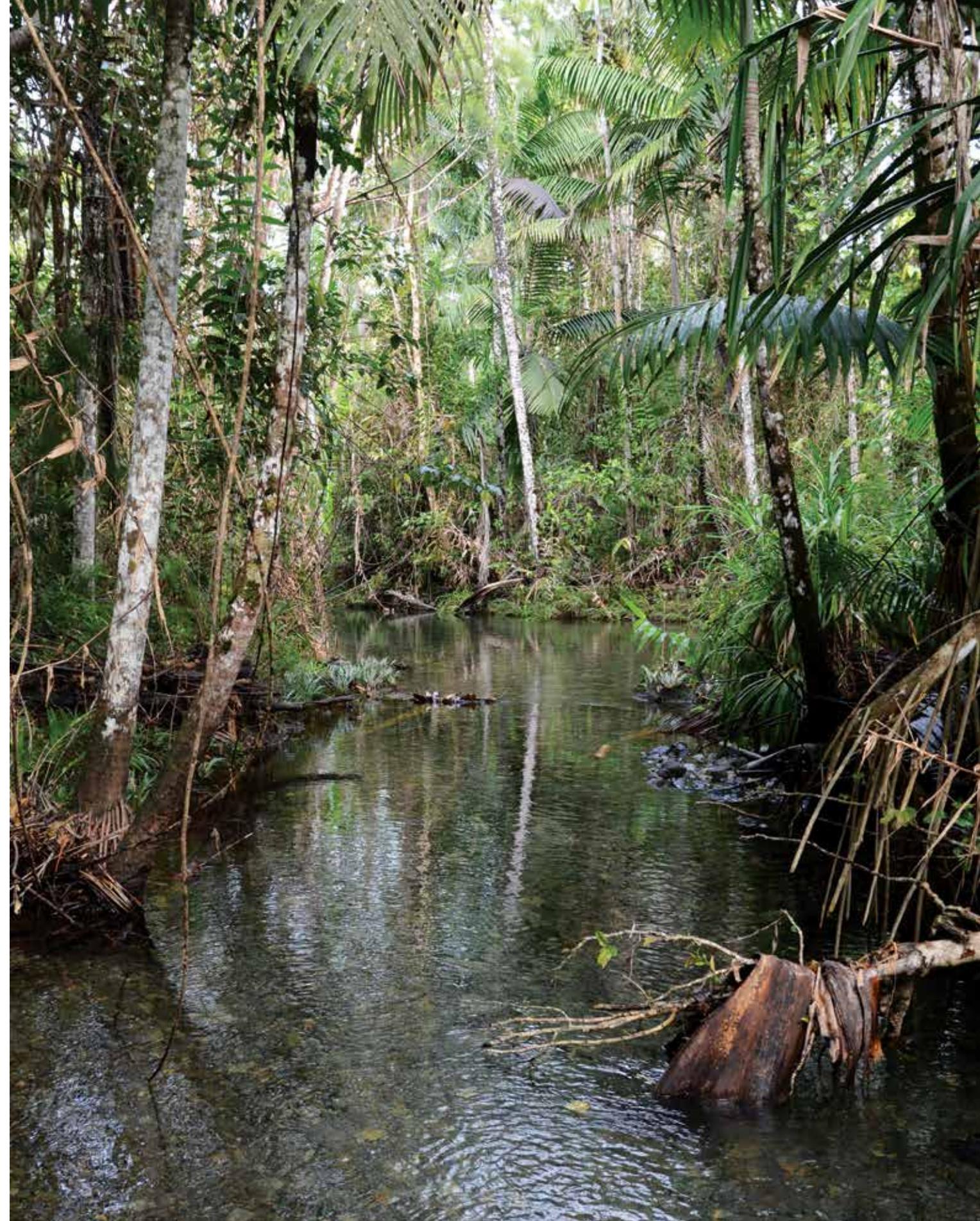
Streams and rivers in the Solomon Islands are different from those of continent landmasses such as Australia. Insular streams and rivers are relatively short (<100 km), straight, have steep channels with small, narrow catchments and few tributaries. However, there is a clear distinction of water catchment between larger volcanic islands and small atoll islands. This is mainly based on island size and elevation.

The field survey techniques compiled here are based on Polhemus et al 1992, Parham 2005, Fitzsimons et al., 2007, Jenkins 2009 and are refined based on authors field experiences working in the Solomon Islands.

The survey methods presented are some of the most comprehensive field techniques. They also provide an accurate glimpse of the fishes present in a number of different stream and river habitats in the tropical oceanic island ecosystem. Based on the expert field experience, the fishes within the families Gobiidae and Eleotridae are used as the primary indicators of environmental quality. They are well-studied, occur in observable inhabitants typical of insular tropical systems, and represent critical components of the food web from primary consumers to predators. Importantly they are also valued as protein food source for inland communities.

Site and Standardization

An example of a fish study could be one that is designed to determine the abundance, diversity and biomass of fishes within different reaches of a river system. A survey can be applied to a wide range of habitats from small creeks to large rivers, torrential mountain streams, mangrove swamps and/or upland lakes. The survey/collecting methods used will be selected depending on the habitat type. The river or stream is divided into three sections



depending on the stream lengths, or with known distribution of adult animals. The three sections are known as lower reach, middle reach and upper reach. Lower reach sites are generally from the river entrance to the first major obstacle to fish passage (eg. waterfall, culvert, weir). An estuary is a mixture of salt and freshwater that is freely connected to the ocean, and may also be referred to as the lower reach site.

A middle reach section is composed of pure freshwater at a moderate to low incline with riffle, run, and pool development. There are also two sections of middle reaches section where sampling occur. One was just above the first major obstacle and another taken 100-200 meters further upstream.

The upper reach sites are generally characterized by steep gradient headwater areas with waterfalls and plunge pools. Our approach is generally to sample once above the largest headwater waterfall and once below, although variation in length, grade and waterfall formation mean this may not always be possible.

Generally, it is ideal to sample a river or stream twice in each of the reach in each season. Usually, many techniques are used as is possible at each site. This is to gain the most comprehensive understanding of species present or absent.

Standardization of sampling includes apparatus used, length of reach sampled, sampling time and number of surveyors. Generally, 50 meter sections of streams and rivers are sampled with a combination of a single electrofishing apparatus, several seine and hand nets by 4-6 surveyors from the downstream section of the site working upstream and are sampled for approximately one hour per site.

Methods for Measuring Key Habitat Characters

Temperature (°C)

The distribution and abundance of aquatic plants and fishes changes is partly shaped by water temperature. Changes in temperature will alter the amount of oxygen dissolved in the water with high temperatures decreasing the amount of dissolved oxygen available and also affecting the rate of photosynthesis by algae and other plants. Increases in water temperature will cause an increase in the metabolic rate of organisms in the water. Increased metabolism increases the oxygen demand of fishes, insects and bacteria. A short period of high temperatures each year can make the stream unsuitable for sensitive organisms even though the temperature during the rest of the year is suitable. Some species have different temperature requirements at different stages of life. Generally fish larvae tolerate a narrower range of temperature than do adult fish. Fishes can generally tolerate slow changes in temperature. Thermal stress can occur where the temperature changes more than 1 to 2



TOP: Example of lower stream section the interface between freshwater and salt water. Fish is a source of protein for resource dependent communities, hence management of this resource is critical to ensure there is a persistence of healthy populations.

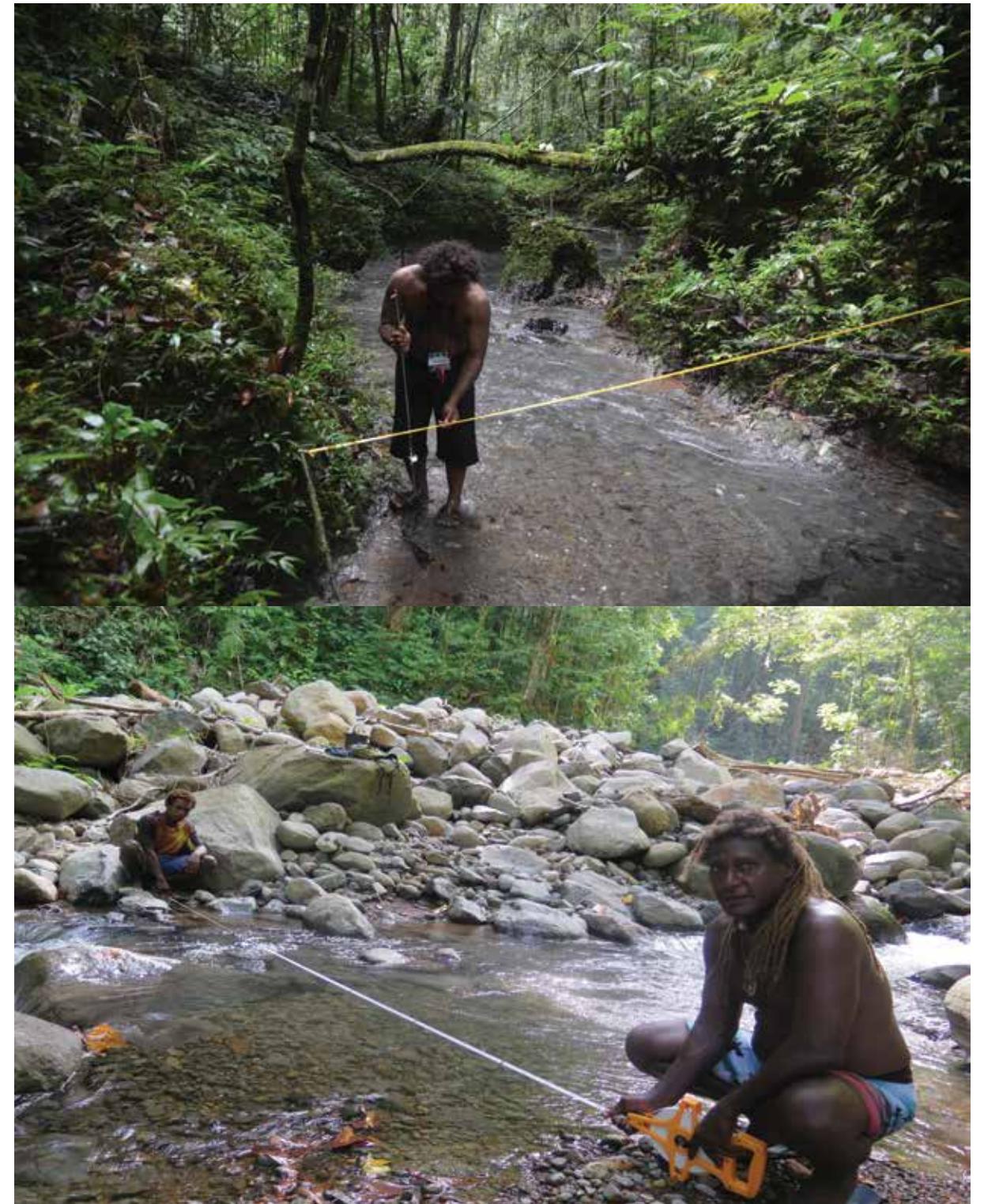
degrees in 24 hours. Temperature rises are often caused by the discharge of heated water into waterways, reduced flow of water due to siltation or damming, reduction in shading along rivers due to deforestation, as well as through increased turbidity from agricultural runoff or algal blooms. Temperature can be taken by handheld probes submerged until the value stabilizes.

pH

pH is a measure of how acidic or basic the water is. On a scale of 0 (extremely acidic) to 14 (extremely basic), water usually has a pH of between 6.5 and 8.5, which is the preferred range for most aquatic organisms. Variation in pH naturally occurs due to the geology of the watershed (e.g. limestone produces more basic water) and salinity (salt water is more basic than freshwater with normal seawater having a pH level of around 8), and organisms are adapted to live within the naturally occurring pH levels in their ecosystem. A change of pH, even slight changes for some organisms can cause death, with immature (larval) stages of insects, amphibians and fish being very sensitive to pH levels below 5. Human activities can change the pH levels of water. Air pollution from motor vehicle emissions containing sulphur dioxides and nitrous oxides can increase the acidity of the water by forming sulphuric and nitric acid. Industrial water, agricultural runoff or drainage from improperly run mines all affects pH levels. Rapidly growing algae and submerged vegetation caused by elevated phosphate and/or nitrate levels can remove carbon dioxide from the water during photosynthesis. This can result in a significant increase in pH levels in a waterway. pH can be recorded using a hand held meter submerged 15 cm below the water surface until the value stabilizes.

Dissolved Oxygen (mg/L)

Dissolved Oxygen can range between 0 and 14 mg/L and is affected by temperature and salinity. As water temperature changes, the highest potential dissolved oxygen level changes. Lower temperatures result in higher potential dissolved oxygen levels and higher temperatures result in lower potential dissolved oxygen levels. The tropical climate and the subsequent warm temperature of the water cause the natural levels of dissolved oxygen to be quite low. This temperature effect is compounded by the fact that living organisms increase their activity in warm water, requiring more oxygen to support their metabolism. Critically low oxygen levels often occur during the warmer months when decreased capacity and increased oxygen demand, caused by respiring algae or decaying organic material, coincide. Naturally occurring salts found in estuarine and marine waters also lowers the levels of



An example of rangers taking stream measurements.



dissolved oxygen. An increase in water temperature due to high turbidity levels, discharge of heated water into waterways, reduced flow of water due to siltation/damming or a reduction in shading along rivers due to deforestation can also decrease dissolved oxygen levels. An increase in aquatic plants/algae through fertiliser runoff or sewage contamination can also decrease the available oxygen in the water. Damming waterways or removing riffles (rocky shallow areas) can decrease the oxygenation of the water through a reduction in the speed of flow or churning of the water. Dissolved oxygen levels below 3 mg/L are stressful to most aquatic organisms. Levels below 2 mg/L are not enough to support life whilst levels between 2 – 4 mg/L are only acceptable to a few forms of organisms that are adapted to low oxygen levels. 4-7 mg/L of dissolved oxygen is acceptable for warm water fish as they are adapted to the low levels of dissolved oxygen found in warm waters. Dissolved oxygen levels can also be expressed as a percentage of the maximum possible dissolved oxygen levels at a given temperature. Percentage saturations of over 90% are excellent, 71-90% good, 50-70% fair and below 50% are poor. Saturation levels of between 60-79% are acceptable for most aquatic organisms. Dissolved Oxygen can be measured with a hand held probe submerged 15 cm below the water surface until the value stabilized.

Conductivity (S) and Salinity (ppt)

Measurements of conductivity and salinity assess amounts of dissolved ions such as Calcium, Potassium, Chlorides and Bicarbonates present in water. As such, salinity and conductivity are related. In fact we can roughly estimate salinity by multiplying conductivity by 0.64. Problems in aquatic systems often occur when deep rooted vegetation is removed and water infiltrates soil bringing deep salts to surface. The water then evaporates leaving high salt concentrations to wash into the water body. Many species can only survive in certain salinity ranges so changes in salinity can change the variety of species present. These measures also give us an idea of which species prefer particular salinity or conductivity regimes. Salinity values are also important for determining if electrofishing can be undertaken. Electrofishing is ineffective and can damage the electrofisher in salinities around 5 ppt. We do not use electrofishing in low reach sites with higher salinities.

Conductivity and salinity can be measured with a hand held probe submerged 15 cm below the water surface until values stabilized.

Current speed (m/s):

Current speed is a limiting factor for fish communities, preventing certain species from living in an area. Also, fast moving streams tend to have higher levels of dissolved oxygen. Our



Pole seine net.



Collecting water parameters (conductivity, pH, etc) using a hand held meter, as well as recording riparian vegetation during freshwater surveys.

field method of estimating current speed is by floating a plastic lid over a marked ten meter section and timing with a stopwatch. A tip for this method is to start a few meters before the measured area and place floater in mid-stream in estimated “mean” flow conditions for the site. A commercially available flow probe, however, would yield more precise results.

Turbidity (NTU)

High turbidity decreases the amount of light passing through the water column which limits plant growth also affecting the fish communities which feed on and live in plants. High levels of turbidity reduce the ability of the water to support a large variety and number of aquatic organisms. Where there is less light penetrating the water, there will be less photosynthesis occurring and this reduces the levels of oxygen in the water. Also, the water becomes warmer because suspended material absorbs heat from the sun. This also decreases the amount of oxygen dissolved in the water. As many fishes are visual predators, high turbidity levels will also reduce their ability to forage effectively and to avoid predation. To measure turbidity a turbidity tube calibrated to Nephthalometric Turbidity Units can be used. Water is added to the tube until the black indicator lines at the base of the tube are no longer distinguishable and a measurement is taken when this point is reached. If the value was greater than 200 NTU’s then we filled with 2 x the water and multiply the NTU value by 2.

Water body width, depth (m)

Measuring the maximum water body width and depth of a sampling site gives a rough approximation of the volume of water accessible as habitat for fishes. If these values are used in combination with the current speed this can also give an approximation of flow rate (m³/s). Seasonal variation in stream width and depth can significantly change not only the amount of habitable space but also the degree of fish community interaction with bank vegetation and the riparian zone, altering the physicochemical characteristics of the water body. A waterproof fibreglass measuring tape to measure both maximum width and depth can be used. Often maximum depth is gained by using a stick or length of bamboo to probe for the deepest area and then the probe is measured to where the water height has reached.

Riparian zone

The riparian zone pertains to the banks and other adjacent terrestrial environs of the water body. It is the terrestrial/aquatic interface and very important in determining the structure and function of the stream.

Collection Methods

Several types of fishing gear can be used for an aquatic survey. They include gill nets of different mesh sizes, a throw/cast net, beach seine net, a fine mesh net, pole seine net, a small hand net, a spear gun and a electro fisher.

(a) Gill nets

The gill nets are made of monofilament material and have different lengths, widths and mesh sizes. Gill nets are weighted with lead on the bottom (lead line) and have floats on the top (float line). When they stretched to their full lengths the nets can be tied onto two rods at each end, then allow time to soak before being checked.

(b) Cast net

The cast net is made of a nylon cord and has a mesh size of 2 cm. It is circular in shape, approximately 3 m diameter, and is weighted around the circumference. This net is used only at the lower reaches of a river or a stream.

(c) Beach seine net

This net can be pulled in a rough circle, with the bottom edge down as close as possible to the substrate and forward of the top floating edge of the net. This technique can be carried out with care to lessen the number of fleeing fishes. It is commonly used only in slow moving or still waters.

(d) Fine mesh net

This is a very fine mesh size net. One person has to stand at one end of the net while another person pulls it in a circle. The bottom of the net is weighted and is kept close to the substrate. The net will be pulled onto the river’s edge. This technique is used on slow moving and oxbow pools.

(e) Pole seine net

This net can be used in three ways. Firstly, two people can hold the net downstream while another two people kick, splash and remove rubble upstream and swam towards the net. Secondly, the net can be submerged under over-hanging vegetation and while the surrounding vegetation is disturbed to chase the fish into the net, before the net is thrust upwards. Finally, the net can be held behind a person with an electric fishing machine to catch the stunned fish and prawns.





TOP: An example of electrofishing.
 ABOVE: Using a hand net to collect fish during freshwater survey.

(f) Hand net

This net can be used to scoop fish that are stunned by the electric fishing machine and are floating on the surface of the water or are lying at the bottom of the substrate.

(g) Spear gun

This is a long thin iron rod used with an elastic rubber band. It is very useful in collecting fast moving fish and fish hiding under tree roots or under big rocks in a pool. The spear gun is used while swimming with mask and snorkel.

(h) Electric fishing machine

This electric fishing machine can be used extensively in a number of different habitat types like shallow rapids, shallow slow flowing waters and the banks of the deeper pools. A fine mesh net attached to the rod and two other persons can be positioned behind the person with the electric fishing machine with a fine mesh net and hand net each to collect the stun fish.

(i) Visual observation

This method can be used in big clear pools while swimming underwater with a mask and a snorkel. A tape measure is used to run a transect line and fish within a meter distance from each side of the line can be counted from one end of the pool to the other.

(j) Hand gleaning

This method can be used in pools where prawns are dominant. Prawns are collected by hand from under stones and rocky substrate.

Physical parameter equipment

A number of different equipment's can be used to measure the physical parameter of the survey site. A portable Global Positioning System (GPS) can used to take the position and altitude of the sampling sites. A water clarity can be measured by estimating the water clarity in percentage ranging from 0 to 100%, with 100% denoting pristine freshwater. River flow is measured by calculating the flow of an object from point to point B over a length of one meter using the formula $Velocity = \text{distance (meters)}/\text{time (seconds)}$. Other equipment to measure the water parameters are:

- Water meter, to measure dissolved oxygen, conductivity, salinity, pH and temperature

- A 100 m tape to measure to measure the length, width and depth of a sampling site.

At each sampling sites, the physical parameters are measured and recorded before the fish survey begins. The site location, substrate type, the creek and river type and the flow rate will determine the fishing method use at a particular site.

Processing

During field collections all known fish species are counted, measured and returned to the water. Unidentified fish specimens can be collected and taken back to the laboratory. The fish specimens are fixed in 10% formalin, stored in sampling bottles and labeled with site and date of collection. After five to seven days the fish will be transferred into 70 % ethanol.

In the laboratory, all fish collected can be counted, identified and their standard length recorded. You can start your own reference collections or send them to a museum collection for safe keeping.

Fish

All fishes are identified to the lowest possible taxonomic level using available literature. Help can be also sought from fish taxonomists to identify or verify some identification.

Aquatic invertebrates caught can be also collected as a means to determine the relative biodiversity and food availability. Furthermore, the riparian plants along the water systems can be recorded to identifying habitats.

Invertebrates

All invertebrates collected such as snails, prawns, crabs and freshwater insects can be identified to the lowest possible taxonomic level using available literature. Specimens can be shipped to taxonomist's experts to identify or verify the identifications.

Flora

The riparian plants from sampling sites can be identified on site or specimens brought back to the village and seek help for identification from other villages or local plant taxonomists.



Visual observations of fish.



Prepping freshwater fishes for further taxonomic work.

Chapter 10. Resource Materials

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Rangers are very important in maintaining green lines that protect conservation areas, marine protected areas, wildlife refuges, historic sites, or resource management areas. Whether they are conducting awareness programs, enforcing laws, accompanying visitors, or assisting researchers, rangers are essential to establishing secure, enjoyable and memorable experiences. The 'Solomon Islands Ranger Skills Guide' is intended to assist local rangers with skills and practical training that may be useful in managing and monitoring natural resources at their respective sites. It is intended to help the relevant government ministry manage, protect and preserve Solomon Islands natural heritage, and to support the conservation efforts that will ensure the persistence of ecologically and historically important sites.



Rangers attending the first Solomon Islands Ranger training (2015) coordinated by the University of Queensland and Solomon Islands Community Conservation Partnership, in collaboration with local and overseas partners.

