Sutton, P. E., H. R. Mushinsky, and E. D. McCoy. 1999. Comparing the use of pitfall drift fences and cover boards for sampling the threatened sand skink (*Neoseps reynoldsi*). Herpetol. Rev. 30:149–151.

Tinkle, D. W., A. E. Dunham, and J. D. Congdon. 1993. Life history and demographic variation in the lizard *Sceloporus graciosus*: a long term study. Ecology 74:2413–2429.

Zydlewski, G. B., G. Horton, T. Dubreuil, B. Letcher, S. Casey, and J. Zydlewski. 2006. Remote monitoring of fish in small streams: a unified approach using PIT tags. Fisheries 31:492–502.

Herpetological Review, 2011, 42(2), 184–187.

A New Rapid Assessment Technique for Amphibians: Introduction of the Species List Technique from San José de Payamino, Ecuador

The urgent need for baseline amphibian data in light of global population declines (Stuart et al. 2004) has led to a call for accurate and robust rapid assessment techniques for amphibian assemblages. This is especially pertinent in areas such as wet tropical rainforest where there is a scarcity of data (Duellman 2005; Gardner et al. 2007) and where robust and comparable data are particularly required to underpin difficult management decisions. The lack of amphibian data from wet lowland forest habitats is often a result of the logistical problems of conducting research in such areas (Doan 2003; O'Dea et al. 2004; Poulsen et al. 1997) where dense understory vegetation, inaccessible terrain, extreme rainfall and humidity, and seasonality (Doan 2003) hinder research. High species diversity and clustered distributions further complicate surveying (O'Dea et al. 2004; Poulsen et al. 1997). Amphibian survey methods used in temperate climates are not applicable to the rainforest environment in many instances (Doan 2003). This, coupled with the fact that rainforest inventorying is often abbreviated due to both the urgency of conservation concerns in the tropics (O'Dea et al. 2004; Heyer et al. 1994; Poulsen et al. 1997; Poulsen and Krabbe 1998) and by cost (Doan 2003, O'Dea et al. 2004; Pellet and Schmidt 2005), points to the need for amphibian rapid assessment techniques specifically designed for work in the difficult tropical rainforest environment (Doan 2003; Poulsen et al. 1997).

The aim of this paper is to introduce the Species List Technique (SLT) (MacKinnon and Phillipps 1993) as a rapid assessment technique for inventorying amphibian assemblages in tropical rainforest environments. We discuss the suitability of this technique to assess species richness and species accumulation. Results are compared over short (21 day) and longer (48 day) time periods to allow assessment of effectiveness in a rapid assessment context. Impact of the methods on the habitat and fauna, plus time and financial costs are also considered qualitatively. A set of standardization suggestions are made to ensure comparability between studies.

ANNA P. MUIR*
Institute of Biodiversity, Animal Health and Comparative Medicin
Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ,UK
MARTIN C. A. MUIR
Centre for Environmental Change and Human Resilience
School of the Environment, University of Dundee, Dundee,
DD1 4HN, UK

**Corresponding author; e-mail: a.muir.2@research.gla.ac.uk*

The Species List Technique (MacKinnon and Phillipps 1993) was designed for rapid assessment of avifauna especially in tropical rainforest environments (O'Dea et al. 2004; Poulsen et al. 1997). This straightforward technique is standardised to provide an index of effort for opportunistic encounters, meaning no data are excluded from analysis (O'Dea et al. 2004). Cumulative species richness is related to the number of observations, rather than space or time, allowing for moderate differences in field technique and observer experience (Herzog et al. 2002). This standardization makes the SLT much more valuable for species assemblage comparisons between studies and sites than species inventories alone (Herzog et al. 2002). The time efficiency of the method, through constant data collection while in the field, lends itself for use in a rapid assessment setting.

All species seen or heard are recorded in species lists of predetermined length. The number of species recorded per list is chosen to reflect species richness. Lists of 8 to 20 species have previously been used for bird surveys (Bibby et al. 1998; Herzog et al. 2002). Different geographic areas can only be compared when species lists of the same length have been used. Therefore, it is important that standard amphibian list length should reflect species richness of all tropical areas where the SLT may be used. We assessed the use of lists of 3, 5 and 10 species for our amphibian survey in order to provide a balance between robust sample size for formation of species accumulation curves and comparability between sites of varying richness. The lower the number of species in a list, the more the shape of the accumulation curve (and therefore the species richness prediction) varies depending on sample size (Herzog et al. 2002). However, a high number of species per list will reduce the number of lists compiled and thus the accuracy of the accumulation curve. We found that the number of lists formed using 10 species lists was low (25 lists) and in less diverse tropical regions insufficient data may be collected to create an accumulation curve. Both 3 and 5 species lists gave a large enough sample size to create species accumulation curves. Therefore, based on Herzog et al.'s (2002) conclusion that longer species lists give more robust accumulation curves, we chose to use 5 species lists.

Species List Technique list formation begins when the first individual is observed. Each subsequent species (not individual) is added to the list until 5 species have been observed. Once a list is complete, a new list is started. Species can be repeated between, but not within, lists (Fig. 1). List formation continues throughout the length of the data collection period. Any species that cannot be immediately identified are assigned placeholder names until the species can be identified so that their order in the list is not affected. This data collection method has the key advantage that multiple observers can form their data into a single set of lists by recording the date and time each individual was observed to allow sequential addition of species to form lists during analysis, making time in the field as productive as possible.

Date	Species recorded	List #		
17/11/2007	*Nyctimantis rugiceps*	31	1	*Nyctimantis rugiceps*
17/11/2007	*Pristimantis lanthanites*		2	*Pristimantis lanthanites*
17/11/2007	*Bufo margaritifer*		3	*Bufo margaritifer*
17/11/2007	*Bufo margaritifer*		4	*Pristimantis ockendeni*
17/11/2007	*Bufo margaritifer*		5	*Pristimantis altamazonicus*
17/11/2007	*Pristimantis ockendeni*			
17/11/2007	*Pristimantis ockendeni*			
17/11/2007	*Pristimantis ockendeni*			
17/11/2007	*Pristimantis ockendeni*			
17/11/2007	*Pristimantis altamazonicus*			
17/11/2007	*Bufo margaritifer*	32	1	*Bufo margaritifer*
17/11/2007	*Osteocephalus yasuni*		2	*Osteocephalus yasuni*
17/11/2007	*Pristimantis luscombei*		3	*Pristimantis luscombei*
17/11/2007	*Pristimantis lanthanites*		4	*Pristimantis lanthanites*
17/11/2007	*Pristimantis ockendeni*		5	*Pristimantis ockendeni*
17/11/2007	*Pristimantis ockendeni*	33	1	*Pristimantis ockendeni*
17/11/2007	*Pristimantis ockendeni*		2	*Bufo dapsilis*
17/11/2007	*Pristimantis ockendeni*		3	*Osteocephalus yasuni*
18/11/2007	*Bufo dapsilis*		4	*Ameerega picta*
18/11/2007	*Pristimantis ockendeni*		5	*Hypsiboas cinerascens*
18/11/2007	*Pristimantis ockendeni*			
18/11/2007	*Osteocephalus yasuni*			
18/11/2007	*Ameerega picta*			
18/11/2007	*Ameeerga picta*			
19/11/2007	*Hypsiboas cinerascens*			

Fig. 1. An example of data collected in San José de Payamino and subsequent creation of Species Lists. Arrows highlight how individual observations are amalgamated into lists based on the order in which they are observed. Note that species are recorded only once per list regardless of number of individuals observed.

Data collection took place between June 2007 and May 2008 in the 27,000-hectare lowland tropical rainforest territory of the Quichua community San José de Payamino, Orellana Province, Ecuador. Three sites within this territory (Sacha huasi, Bigay, and Paushiyacu) were each visited three times in one year and data were collected over the period of a week at each site (three weeks per site in total). However, due to logistical constraints, data collection could not take place during every day spent at the sites. Therefore, the number of days spent in data collection varied between 4 and 7 days during the week spent at each site. The methods were assessed separately over a short term (1 week at each site, totalling 21 days of data collection) and longer term (3 weeks at each site, totalling 48 days of data collection) period.

Species were recorded during night visual surveys utilizing pre-existing transects, opportunistic daytime observations and identification of calls. Each of three sites contained five parallel cut transects, each 100 m in length, with 20 m separation between transects. Visual sweeps were conducted along each transect, 2 m either side and up to 2.5 m in height, including low intensity disturbance of leaf litter, rolling small logs and turning over leaves. Detectability differences among species due to visibility, size or volume of calling were partially addressed by this methodical searching during night transects as reflected by the fact that one caecilian species (Oscaecilia bassleri) and two salamander species (Bolitoglossa altamazonica and B. peruviana) were observed. However, biases due to detectability are of concern with, although not unique to, this method (Bibby et al. 1998) and care must be taken to limit this bias. Transects are not a pre-requisite for SLT data collection and it is possible to include targeted areas while in the field, for example high density sites such as breeding pools in order to catalogue as many species as possible. Targeting like this is important for species where there are detectability issues and is not possible in more rigid sampling methods (Herzog et al. 2002). Opportunistic daytime observations included any amphibians observed around camp and on forest walks that were not part of targeted searches. Once a week, the first five calls heard at dusk were identified by comparison with reference recordings (Read 2000). Species accumulation curves were constructed by plotting the cumulative number of species observed as a function of list number (Gotelli and Colwell 2001). Species accumulation curves can be used as an indication of whether sufficient sampling effort has been undertaken to catalogue the total species richness of the area (Bibby et al. 1998). Species accumulation curves can also be extrapolated to show whether expected total species richness varies between areas (O'Dea et al. 2004). Chao 2 (Chao 1987) was used as an estimator of species richness as it has been shown to be effective in areas where many species are rare (O'Dea et al. 2004).

During the short term collection period, 35 species were recorded using SLT, with this number increasing to 55 in the longer time period. The accumulation curves were used to quantify whether the study area had been comprehensively surveyed (Fig. 2). The species accumulation curves did not reach an asymptote over either the short or longer time period. Thus, the number of new species being recorded had not declined, indicating that the species inventory for this study site had not yet reached completion. This is a reflection of the high amphibian species richness of San José de Payamino and the amount of effort needed to inventory such diverse areas. The Chao 2 estimator value of 41±10.74 for short term SLT is an underestimation of the total species richness and with a large standard deviation has limited accuracy. However, the longer term SLT Chao 2 value of 80.08 ± 0.24 is plausible given known species numbers in nearby lowland rainforest areas of Ecuador (84 amphibian species recorded in Jatun Sacha: Vigle 2008) and has a small standard deviation. Regression lines, extrapolated from the accumulation curves to give a prediction of total number of species in the area, gave predicted species numbers of 60.19 with the SLT long term trial and 60.45 with the SLT short term trial. These values, however, do not match with the Chao 2 estimate of species richness, which is much higher. This could be due to the large number of rare species, for which only one or two individuals were observed. Chao 2 has been shown to be a robust estimator in these circumstances (O'Dea et al. 2004). The prediction made by extrapolating the accumulation curves will be inaccurate due to the curves not having reached an asymptote (Gotelli and Colwell 2001). The SLT method has demonstrated that this area is not yet adequately inventoried and that amphibian surveying needs to continue in San José de Payamino. The complete number of species present is undoubtedly higher than the 55 thus far observed and the richness of this area needs to be accurately estimated before it can be compared with other sites. The high conservation value of this area has been shown by the amphibian species observed thus far. Further study must be undertaken for its full importance to be realized.

In light of amphibian sensitivity to habitat disruption (Gardner et al. 2007), it is important to consider the impact to the environment of any biological surveys. The Species List Technique requires no cutting of transects, and species searches can be carried out in any manner. Frequent disturbance to a site through having to repeat data collection at specified transects is avoided. If call surveys are included in list construction, site disturbance can be further decreased. Logistically, SLT needs little in the way of equipment, other than a notebook, ID guide and pencil, and therefore the expense associated with this methodology is negligible. Efficient data collection leads to rapid recording of species present, permitting more comprehensive, comparable inventories to be created during the time available. Personnel with a moderately varied range of experience can carry out data collection without creating bias (O'Dea et al. 2004) as richness is standardized in terms of number of observations rather than time. Therefore, sufficient time can be taken to ensure accurate identifications. This has obvious benefits to expeditions, where every member can take part in data collection, increasing the likelihood that an area will be comprehensively surveyed in the time available.

Standardization of SLT between users and sites will maximize comparability, a key benefit of the technique. Therefore, we recommend that five species lists are used for all studies. Researchers should ensure systematic as well as opportunistic searches to allow for differences in detectability between species. Species observations should also include day and night active species, as well as all habitat types within the area being surveyed to ensure comprehensive coverage. In seasonal areas, timings of surveys must also reflect activity periods of different species. Call surveys should only be carried out for areas where applicable reference recordings are available and the observer is confident in accurate identification. Areas should not be compared until they have been comprehensively surveyed, as assessed by reaching an asymptote in their species accumulation curve.

No single method will ever satisfy all scientific preferences and logistical constraints that befall field investigations (Doan 2003; O'Dea et al. 2004). Therefore, a compromise must be reached to take into account expense, environmental limitations, time constraints and the findings that can be taken from an investigation. When time is severely limited due to expense and the necessity for baseline biodiversity data in areas of conservation concern, then rapid assessment of a site is the best compromise (Heyer et al. 1994). The aim of this study was to assess whether SLT, previously only used to survey avifauna (O'Dea et al. 2004; Poulsen et al. 1997; Poulsen and Krabbe 1998), could be applied to amphibian assemblages. The Species List Technique facilitates rapid species inventorying alongside richness estimation, allowing standardized comparisons between areas where time for surveying is constrained. We therefore recommend the Species List Technique for the rapid assessment of amphibian assemblages in rainforest environments.

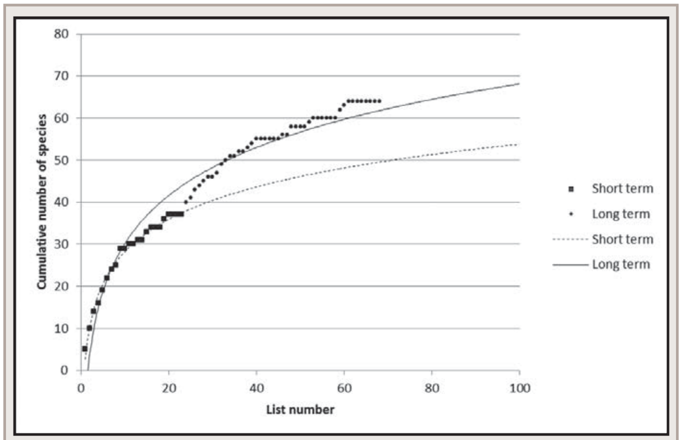

Fig. 2. Logarithmic species accumulation curves by list shown in terms of short or longer data collection periods. For longer-term data each curve represents the average value of 30 randomizations of sampling order and 10 randomizations for short term data. Logarithmic regression lines forecasted forward by 32 periods.

Acknowledgments.—We thank Roger Downie for offering his expertise and for reviewing the manuscript, and Stewart White for advice throughout this study. Thanks especially to Rachel Donnachie as well as Fraser Ross and Rafal Tusinski for their help with the fieldwork, as well as all the Payamino guides who contributed, especially Lucio Cejua and Roberto Purraquilla. Thanks to the community of San José de Payamino who permitted us access to their territory and to the Payamino Project who facilitated and supported this work. Thanks to Twycross Zoo and the Royal Geographical Society (with IBG) for their fieldwork support. Fieldwork followed the University of Glasgow Amphibian Care and Use in Fieldwork and Laboratory Research Guidelines. We thank anonymous reviewers for their feedback on an earlier version of the manuscript.

Literature Cited

Bibby, C., M. Jones and S. Marsden. 1998. Expedition Field Techniques: Bird Surveys. Expedition Advisory Centre (RGS), London. 134 pp.

Doan, T. 2003. Which methods are most effective for surveying rain forest herpetofauna? J. Herpetol. 37:72–81.

Duellman, W. E. 2005. Cusco Amazónico: The Lives of Amphibians and Reptiles in an Amazonian Rainforest. Comstock Publishing, Ithaca and London. 433 pp.

Gardner, T. A., E. B. Fitzherbert, R. C. Drewes, K. M. Howell, and T. Caro. 2007. Spatial and temporal patterns of diversity of an east African leaf litter amphibian fauna. Biotropica 39:105–113.

Gotelli, N. J., and R. K. Colwell. 2001. Quantifying biodiversity: procedures and pitfalls in the measurement and comparison of species richness. Ecology Letters 4: 379–391.

Herzog, S. K., M. Kessler, and T. M. Cahill. 2002. Estimating species richness of tropical bird communities from rapid assessment data. The Auk 119:749–769.

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. A. C. Hayek, and M. S. Foster (eds.). 1994. Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Smithsonian Institution Press, Washington and London. 364 pp.

MacKinnon, J., and K. Phillipps. 1993. A Field Guide to the Birds of Borneo, Sumatra, Java and Bali. Oxford University Press, Oxford. 692 pp.

O'Dea, N., J. Watson, and R. Whittaker. 2004. Rapid assessment in conservation research: a critique of avifaunal assessment techniques illustrated by Ecuadorian and Madagascan case study data. Divers. Distrib. 10:55–63.

Pearman, P. 1997. Correlates of amphibian diversity in an altered landscape of Amazonian Ecuador. Conserv. Biol. 11:1211–1225.

Pellet, J., and B. R. Schmidt. 2005. Monitoring distributions using call surveys: estimating site occupancy, detection probabilities and inferring absence. Biol. Conserv. 123:27–35.

Poulsen, B. O., and N. Krabbe. 1998. Avifaunal diversity of five high-altitude cloud forests on the Andean western slope of Ecuador: testing a rapid assessment method. J. Biogeogr. 25:82–93.

———, ———, A. Frolander, M. B. Hinojosa, and C. O. Quiroga. 1997. A rapid assessment of Bolivian and Ecuadorian montane avifaunas using 20-species lists: efficiency, biases and data gathered. Bird Conserv. Int. 7:53–67.

Read, M. O. 2000. Frogs of the Ecuadorian Amazon—A Guide to their Calls (Audio CD and picture guide). Morely Read Productions, Cornwall.

Stuart, N. S., J. S. Chanson, N. A. Cox, B. E. Young, A. S. L. Rodrigues, D. L. Fischman and R. W. Waller. 2004. Status and trends of amphibian ceclines and extinctions worldwide. Science 306:1783.

Vigle, G. O. 2008. The amphibians and reptiles of the Estación Biológica Jatun Sacha in the lowland rainforest of Amazonian Ecuador: A 20-year record. Breviora 514:1–30.

Herpetological Review, 2011, 42(2), 187–191.

A Taping Method for External Transmitter Attachment on Aquatic Snakes

GLENN D. WYLIE*
JEFFREY J. SMITH
MELISSA AMARELLO
MICHAEL L. CASAZZA
United States Geological Survey, Western Ecological Research Center
Dixon Field Station, Dixon, California 95620, USA

** Corresponding author; e-mail: glenn_wylie@usgs.gov*

Radio telemetry is extremely useful for studying habitat use and movements of free ranging snakes. Surgically implanting radio transmitters into the body cavity of snakes is standard practice in most studies (e.g., Reinert and Cundall 1982; Weatherhead and Blouin-Demers 2004), but this implanting method has its drawbacks. Surgery itself is risky for individual snakes because of the potential for infection or incomplete healing of the incision site. Also, transmitters that are small enough to be carried by small or slender snakes have a relatively short bat tery life and need to be removed or replaced often, thus requiring frequent surgeries. In rare or endangered snake species, the risk of using invasive implantation surgery may not be merited. External attachment methods are relatively non-invasive and allow removal and replacement of radio transmitters on smaller snakes. The Giant Gartersnake (*Thamnophis gigas*) is a semi-aquatic snake endemic to wetlands of the Central Valley of California, USA, and is federally and state listed as threatened (U.S. Fish and Wildlife Service 1999). Telemetry studies of the habitat use and movements of this species typically used surgically implanted radio transmitters, but this method is limited to larger snakes, primarily females, because of size requirements for surgery (> 250 g). To