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A PROTOCOL FOR GEOGRAPHICALLY RANDOMIZED SNAIL SURVEYS IN SCHISTOSOMIASIS FIELDWORK USING THE GLOBAL POSITIONING SYSTEM

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Abstract. A protocol was created for performing geographically randomized snail surveys for schistosomiasis research using the global positioning system (GPS). This protocol differs from traditional surveys in its ability to accurately map and measure the spatial distribution of snail habitat. The protocol was used to map irrigation ditches, the primary habitat for *Oncomelania hupensis,* in two residence areas in Sichuan Province, China. From the 7,450 meters of mapped ditches, snail surveys were performed at 203 random sites along the ditch network. Of these, 116 (57.1%) sites had snails. The total number of living snails captured was 2,014, resulting in an average snail density of 0.27 snails per linear meter of potential habitat.

Estimation of the density and distribution of vectors and intermediate hosts of infectious disease is central to public health-control decisions, often resulting in the need to choose a particular intervention in one location versus another.[1] In China, snail surveys have traditionally been used by researchers to estimate the potential risk for schistosomiasis transmission. However, these surveys provide little more than estimates of the mean number of snails and positively-infected snails for an area, with no information on the geographic distribution of the snails or the size and extent of the habitat.[2,3] Here we present a snail sampling protocol using global positioning systems (GPS), which offers the benefit of geocoding snail survey results, but more importantly provides for accurate measurement of the potential habitat, which in turn allows for the calculation of snail density. Snail densities rather than snail counts are better estimates of infection risk, and can be compared among villages or among areas within a village, in order to identify locations for interventions that include focal mollusciciding and chemotherapy.

The protocol was demonstrated for two residence areas in Magou Township, Meishan County, a 1.5 square kilometer area endemic for schistosomiasis in Sichuan Province, China. Irrigation ditches comprise habitat in this region for snails, which live in the soil just above the water line of the species *Oncomelania hupensis,* the intermediate hosts for schistosomiasis.

A ditch map of the total snail habitat area was created by tracing the ditch network on foot with a GPS unit (Trimble GeoExplorer, Trimble Navigation Limited, Sunnyvale, CA) recording each ditch segment as a separate line feature with measurements taken every 3 seconds. This GPS data was differentially corrected with data from a stationary base station (Trimble 4000 SSI, Trimble Navigation Limited) with measurements taken every 3 seconds, an error-correcting process,[4] to create a sufficiently accurate map of the ditches for the two residence areas. Recent changes in GPS have removed the need for differential correction, allowing such maps to be created cost-effectively with a single inexpensive consumer-grade GPS unit. While tracing the ditch, various characteristics (ditch type, construction type, width, depth, and slope) and identifying data (collection ID, date, and time) were recorded for individual ditch segments, allowing for the visualization of these ditch attributes in the digital ditch map (Figure 1).

For the snail survey, either surveying at fixed intervals or randomly-chosen locations is reasonable; however we chose to demonstrate the latter, more complicated method. For the demonstration, the sample rate was arbitrarily chosen at roughly one sample for every 36 meters. A more appropriate sampling rate should be established based on the spatial autocorrelation of snail clustering for the region under study. The locations were chosen by first computing the total linear length of the entire ditch network (7,450 m), followed by generating 203 random numbers between 0 and 1. Multiplying these numbers by the total ditch length provided 203 random survey locations. Distances from the head of the ditch segments to each of the survey locations were calculated, allowing a group of fieldworkers to easily locate the sites with a printed ditch map and measuring tape, without each of them needing a GPS unit, saving both time and cost. Snail surveys were performed at each of the locations, by counting all snails within a kuang (the typical Chinese square sampling area of 0.11 m^2) placed at the edge of the water line. Of these locations, 116 (57.1%) sites had snails. The total number of living snails captured was 2,014, resulting in an average snail density of 0.27 snails per linear meter of potential habitat. The snail distribution was fit to a negative binomial distribution resulting in an estimated mean of 9.92 and aggregation of 0.23 (Figure 2). The infection rate of 0.099% (2 positive snails) was determined by microscopic inspection of crushed snails.

The ditch mapping was completed in a single day using two GPS rover units. The snail survey was completed on the following day using two teams of six individuals.

The protocol can be generalized to other scenarios such as performing snail surveys for marsh areas or other nonlinear habitats. Any arbitrarily-shaped habitat area can be traced using GPS to create a universe of choices from which locations can be randomly sampled. The spatial distribution of snail populations can be easily incorporated into geographical information systems (GIS) along with other spatial information such as the locations of contamination sources, water contact, and habitation for visualization and analysis.[5] Such a system would help identify households near high snail populations for chemotherapy and high snail popula-

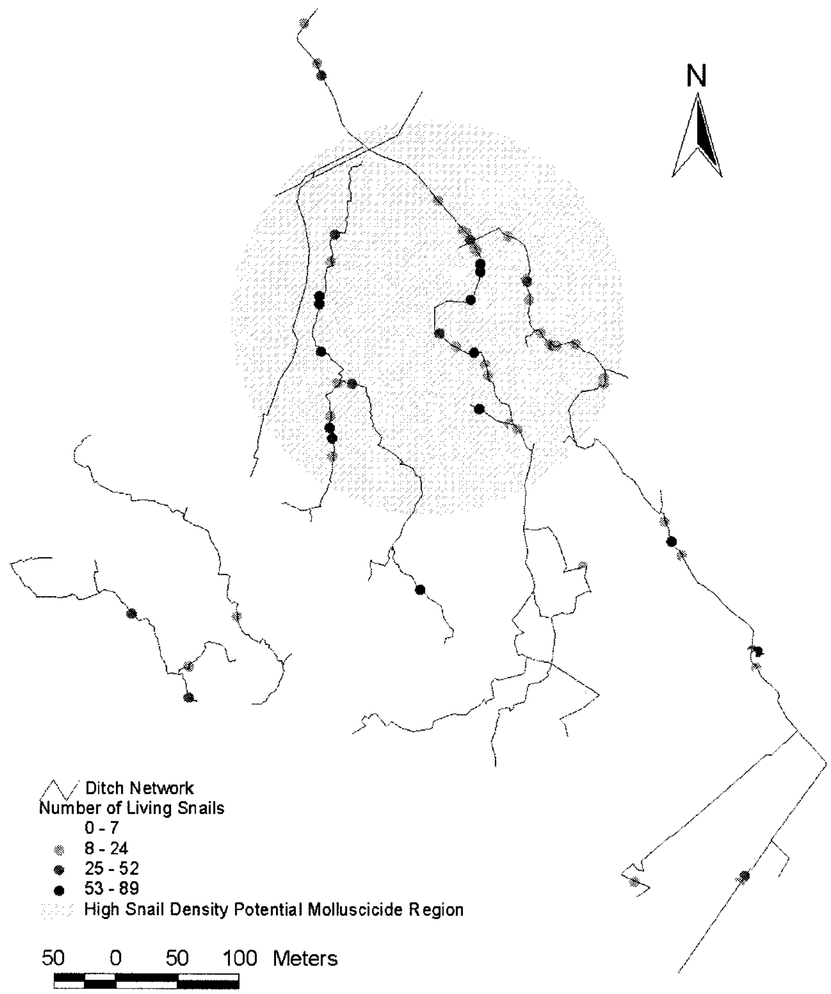

FIGURE 1. Ditch map of snail habitat for two residence areas in Magou Township (103°37′E and 30°8′N).

tions near water contact and contamination locations for molluscicide application.

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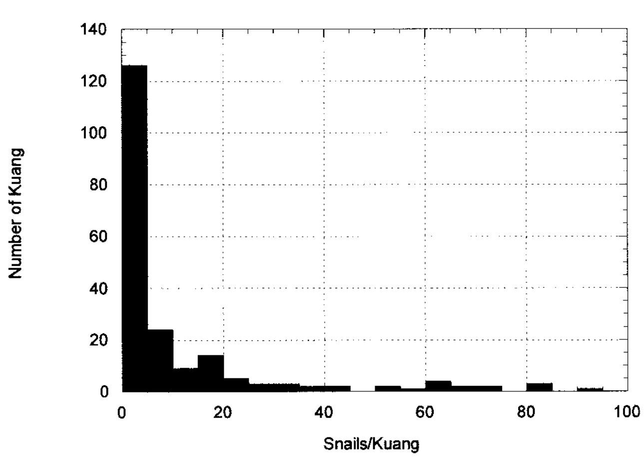

FIGURE 2. Histogram of the number of snails per kuang (the typical Chinese square sampling area of 0.11 m^2) for the Magou Township Survey.

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REFERENCES

1. WHO Expert Committee on the Control of Schistosomiasis, 1993. *The Control of Schistosomiasis: Second Report of the WHO Expert Committee.* Geneva: World Health Organization.
2. Gu X,1990. Epidemiological investigation of schistosomiasis in Minhe and Hexing villages, Xichang, Sichuan Province. Chengdu, Sichuan, PRC: Sichuan Institute of Parasitic Disease (in Chinese).
3. Li Y, 1990. Snail ecological observation in Xichang experimental fields, Sichuan Province. Chengdu, Sichuan, PRC: Sichuan Institute of Parasitic Disease (in Chinese).
4. Hightower AW, Ombok M, Otieno R, Odhiambo R, Oloo AJ, Lal AA, Nahlen BL, Hawley WA, 1998. A geographic information system applied to a malaria field study in western Kenya. *Am J Trop Med Hyg 58:* 266–272.
5. Openshaw S, 1996. Geographical information systems and tropical diseases. *Trans Roy Soc of Trop Med Hyg 90:* 337–339.