Figure 3-9: Map of Indonesia showing the study areas.

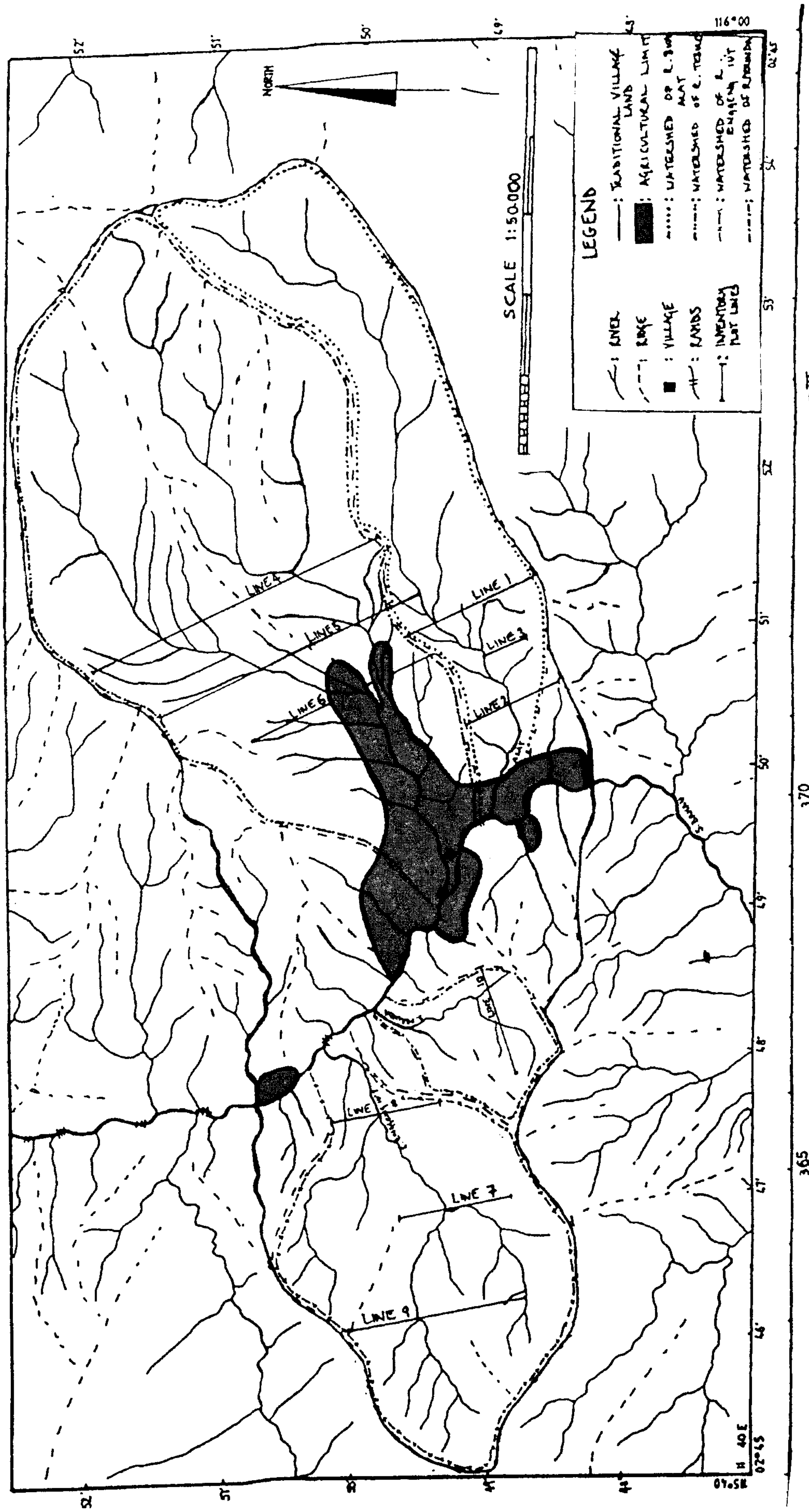

Figure 3-10: Inventory map of the Long Tebulo Village area.

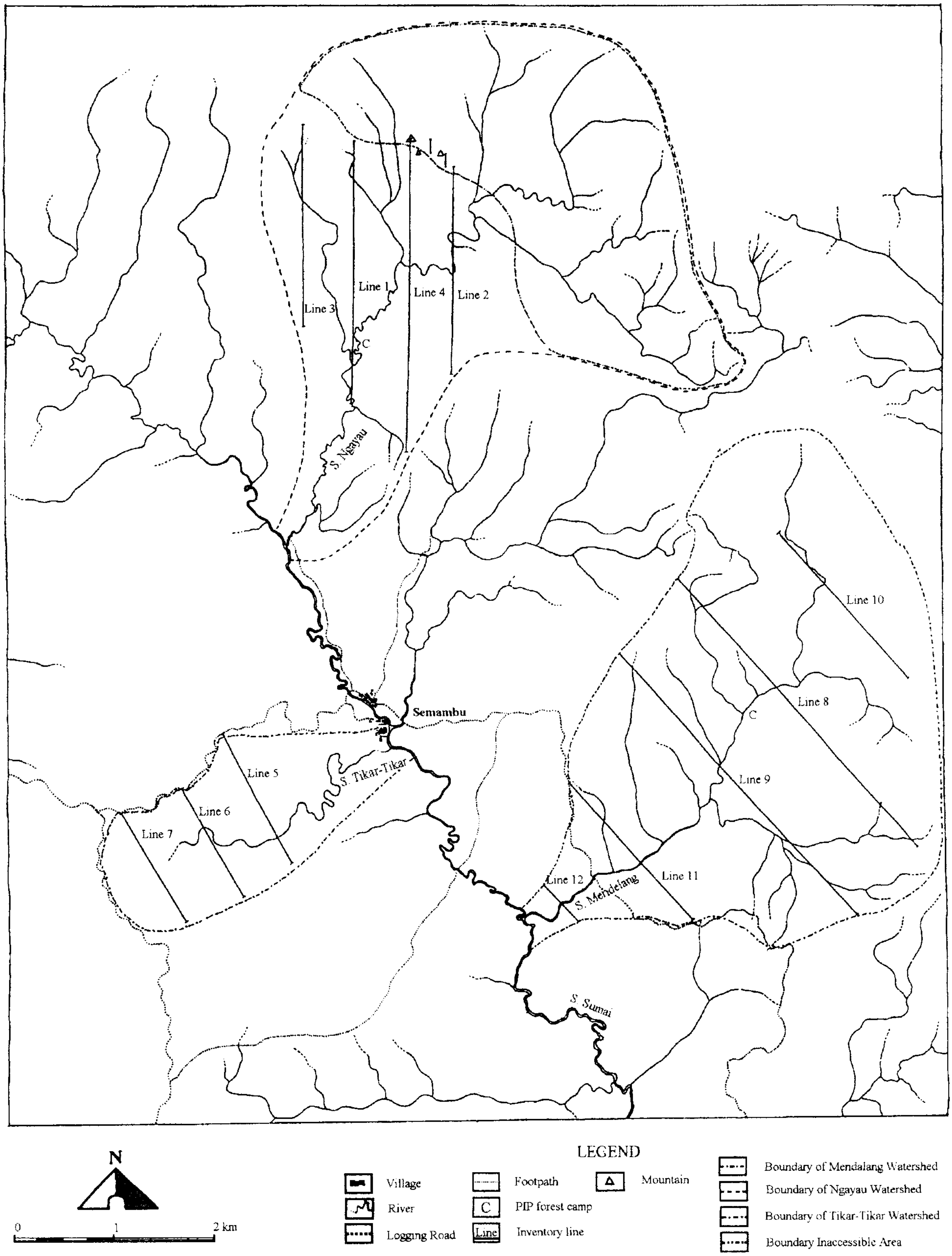

Figure 3-11. Inventory map of the Semambu Village area, Jambi Province, Sumatra.

Results from Semambu village. Some of the major results included:

- Evidence that Ngayau is the richest of the areas in most of the forest resources included in the inventory, such as timber trees, fruit trees, honey trees, *kemenyan* trees and bamboo. For this reason it is considered the area most important to the villagers. However, other areas in the inventory are also important because other resources are more common there; for example Tikar-tikar had the highest concentrations of *salak* and rattans and Mendalang had more *lipai*.

- Evidence that very few *durian* trees are regenerating. Unlike all other timber and fruit trees, there were more *durian* in the larger >31 cm d.b.h. class than in the 5-30 cm d.b.h. class. This spurred a discussion amongst the villagers about how their ancestors had originally planted the trees and resulted in a resolve to plant more trees in the near future to ensure a supply for future generations.

3.5.2.4 Lessons Learned

In addition to completing two trial inventories, members of the PIP team and villagers also evaluated the participatory mapping and inventory method. This evaluation was made using a number of techniques including: formal interviews of villagers after the community meetings, formal observations made during all meetings, informal feedback from villagers and PIP team members, analysis of precision, and analysis of the check data.

From this the following general observations have been made:

1. Were the inventory estimates precise? Tables 3-8 and 3-9 show, for Long Tebulo and Semembu villages respectively, the estimated overall mean number of plants per hectare for all of the chosen forest area together, the 90% confidence limits for this mean and the sampling error (the 90% confidence limits expressed as a percentage of the mean) for each of the chosen forest resources. The sampling errors were on the whole higher (or less precise) in Long Tebulo compared to Semambu. This is no doubt due to the lower number of plots established in Long Tebulo, where 347 plots were established, compared to Semambu, where 998 plots were established.

Tables 3-8 and 3-9 also show, for Long Tebulo and Semambu respectively, the sampling errors that can be achieved when the number of plots in the inventory are 2,500 and 10,000. If all forest resources which were considered extremely variable are excluded (i.e. those with a coefficient of variation (CV%) of greater than 700%), then a plot number of 2,500 is sufficient to bring the remaining nine resources in the Long Tebulo inventory and the remaining fifteen resources in the Semambu inventory to sampling errors of 20% or lower (at 90% probability). A plot number of 10,000 is sufficient to bring the same resources to sampling errors of 10% or lower.

The cost of achieving a desired sampling error is higher in Long Tebulo than in Semambu. In Long Tebulo, the steeper terrain only allows an average of 20 plots to be finished by one team in one day. Thus a sampling error of 10% or less for all but the most variable resources (which would require 10,000 plots to be established) would cost 500 team days, and a sampling error of 20% or less for the same resources (which would require 2,500 plots to be established) would cost 125 team days. In Semambu, an average of 30 plots could be finished per team per day. Here, a sampling error of 10% would cost 333 team days and a sampling error of 20% would cost 83 team days.

2. Were the inventory data accurate? Accuracy could not be measured directly as the "true" data values were not known, however, it was approximated by comparing the data gathered from the same plots by two different teams. Tables 3-7 and 3-8 show the results of three checks for Long Tebulo and Semambu, respectively. In Long Tebulo, there is no discernible trend over time in the differences between the original and the check data, perhaps a trend would have been observed had there been a larger number of plots revisited in each check. In Semambu the trend over time is a decrease in the differences between the original data and the check data. This improvement in accuracy is largely due to the information feedback to the teams from the check data. For this reason checks should be done at a higher intensity at the beginning of the field work, and lowered as the work progresses and fewer discrepancies between the original data and the check data can be seen.

The differences between original and check data were particularly large for some forest resources. These differences can be divided into four major types of errors. The teams found that some of these types of errors could be improved once discovered, whereas others continued to be a problem.

- *Small plants were often missed.* This error occurred for all small herbs, shrubs, saplings and seedlings, such as the <10 cm d.b.h. *sekau, bekai lanya, bekai lan* and *temaha* in the Long Tebulo inventory and *pasak bumi* in the Semambu inventory. The checks in Long Tebulo also showed that women focused on small plants because these often included resources of particular importance to them, such as the cooking herbs *bekai lan* and *bekai lanya*, whereas men tended to enumerate the trees only, therefore teams with no women often missed the smaller plants. There was no such gender difference in Semambu, where it seemed that this error occurred more often when individuals were tired, preoccupied with other tasks or simply less meticulous than their colleagues. This problem was difficult to rectify by discussion; perhaps one solution is to count small plants in smaller subplots, although this makes work in the field and later calculations more complex.

- *It was difficult to determine how to count clumped plants.* This difficulty was experienced for the rattans, the other palms and the bamboo enumerated in the two inventories. There were two types of error for these plants. One error was in determining whether all the size classes of plants should be included in the data. For example, in Semambu some people were counting the rattan clumps down to seedlings, at which stage it becomes very difficult to distinguish species, whereas other people were only counting rattan clumps that had already developed stems. This problem led to vast errors between teams in the first check, but was soon improved after discussion, following which the approach of the latter group of people was adopted. The other error was in determining whether a group of clumps in close proximity were all individual clumps or all one big clump. For example, in Semambu, *rotan udang* produces long underground stolons which lead to a much more spreading clump structure than those of *rotan sego* or *rotan jerenang*. Thus people differed much more in their judgement of what constitutes a clump when counting this species. This problem was difficult to rectify with discussion.

- *There were some differences of opinion about taxonomy.* Most older villagers were extremely good at identifying species, especially those included in the inventories since they were of particular importance to them. However, checks revealed some differences of opinion. In Semambu there was confusion over whether or not to include two types of *kulim*, a timber tree with an edible fruit. Although the two types of tree were from different genera the fruit tasted similar and both were referred to as*kulim*.

3. Were the important concepts underlying this method understood by the villagers?

- *Levels of understanding:* It was clear that not everyone in the villages understood all of the concepts underlying the mapping and inventory method to the same level. However, this was not so important as long as the concepts that are important for community decision-making (such as the potential purposes and objectives of mapping and inventory) are understood by all and as long as the other concepts, such as the technical aspects (including how to use a map or how to sample in order to estimate total quantities), are understood by at least some people, so that they continue to use the method and explain its products long after the PIP team has gone.

- *Who understands the concepts:* Understanding all concepts, particularly the technical ones, was easier for the younger, formally educated people in the village. However, the older, less educated people contributed a specialised knowledge of the area and the resources that was particularly useful when making the sketch maps, planning the objectives, finding the starting points of inventory lines, identifying the plants in the plots etc. Thus the knowledge and skills of the two groups together made for a formidable team, and meant that the maps and inventory data were produced efficiently and were of a higher quality than if outsiders such as the PIP team had tried to produce them by themselves.

4. Was this method participatory?

- *Within the village:* It is important to have participation from all sectors of the village community, as otherwise the decision-making, if made by a small group of villagers only, may be biased by their values and opinions alone. In this project, participation could be said to have been achieved in terms of actual numbers of villagers at meetings and representation of important sectors of society (such as men, women, youths) in all steps of the method; however participation in terms of equal involvement by all in decision-making was not achieved, as the older men tended to dominate the community discussions. This situation could not have been changed without major challenges to traditional institutions; at least this method provided an opportunity for the views of the less vocal groups to be brought forward.

Between villagers and outsiders: The mapping and inventory activities in this project were initiated and directed by outsiders (notably two researchers from the Oxford Forestry Institute), as part of a research project for testing and evaluating a new method. The focus of this project was on developing ways of involving the participation of the villagers in the mapping and inventory activities; the other stakeholders from the region who provided representatives to the PIP team (notably from WWF-Indonesia, the local timber concession and government) were not involved as equal participants.

It should be possible for villagers to initiate and direct the mapping and inventory process themselves. However, some assistance before and/or during the process may be needed from outsiders, in the form of thorough practical training with training materials that can be taken away to use as a basic reference, and equipment such as a base map, compasses and d.b.h. tapes.

The villagers are likely to be able to cover much of the inventory costs (such as labour, food supplies, etc.) if they feel that the products of the activities are of sufficient importance to be worth the expense. However, in most cases it might be unrealistic to expect that the village alone could obtain or pay for the training or equipment mentioned above.

It should also be possible for villagers to conduct this mapping and inventory work as part of a larger team of stakeholders, which might include members from government, non-government or commercial organizations. Mechanisms for involving these other stakeholders as full participants still need to be sought. For various reasons, there is often a high degree of mistrust by villagers of the motivations of outsiders; for this reason an emphasis on transparency in the involvement of all stakeholders is very important. Furthermore, to ensure that the participation of the villagers does not become restricted to a token presence on the team, it is important to try to maintain the villagers' full involvement in the planning of the mapping and inventory activities, in the collecting, compiling and analysis of data and in the implementation of results.

5. Was this method acceptable to the villagers? The ideals of ensuring full participation from all groups in the community at times clashed with culturally accepted norms. For example, in one of the villages the men did not see the need for the participation of women in the meetings and field work. This is a difficult and value-laden issue.

In general, however, the method met the approval of the villagers, although not without some suspicion of ulterior motives on the part of members of the PIP team. The involvement of villagers in the method from start to finish had the effect of decreasing suspicion and raising enthusiasm as time progressed. The feedback from both villages at the end was positive, with villagers commenting that they felt more confident to discuss issues with outsiders or within the village, now that they were armed with written documents to illustrate their statements.

Table 3-6: Forest resources chosen for the Long Tebulo inventory

Lepo Ke' name	Latin name	Uses	Information required
Sekau	*Aquilaria malaccensis (Thymelaceae)*	Aromatic incense with international market value	1. Trees <10 cm trees 2. Trees ≥10 cm trees
Bekai Lanya	*Coscinium miosepalum (Menispermaceae)*	Cooking herb with local market value	All shrubs
Bekai Lan	*Pycnarrhena cauliflora (Menispermaceae)*	Cooking herb with local market value	All shrubs
Sang	*Licuala sp. (Palmae)*	Leaves for roofing and hat making	All clumps
Da'a	*Pandanus sp. (Pandanaceae)*	Leaves for hat and basket making	All clumps with at least one stem
Wai Seka	*Calamus caesius (Palmae)*	Cane for construction and basket making	All clumps with at least one stem
Temaha	*Memecylon garcinddes (Melastomataceae)*	Stem for hunting spears and boat poles	Trees 3-10 cm d.b.h.
Kayu Merang	*(Rubiaceae)*	Timber for house foundations	1. Trees 30-59cm d.b.h. 2. Trees 60-89cm d.b.h. 3. Trees ≥90cm d.b.h.
Kayu Tenak	*Shorea spp. (Dipterocarpaceae)*	Timber for boards and boat building	1. Trees 30-59cm d.b.h. 2. Trees 60-89cm d.b.h. 3. Trees ≥90cm d.b.h.
Kayu Tumu	*Agathis borneensis (Araucariaceae)*	Timber for boards and furniture	1. Trees 30-59cm d.b.h. 2. Trees 60-89cm d.b.h. 3. Trees ≥90cm d.b.h.
Kayu Pung Ubi	*Ochanostachys amentacea (Olacaceae)*	Timber for house foundations	1. Trees 30-59cm d.b.h. 2. Trees 60-89cm d.b.h. 3. Trees ≥90cm d.b.h.
Kayu Kapun	*Dryobalanops lanceolata (Dipterocarpaceae).*	Timber for boards and joints in house construction	1. Trees 30-59cm d.b.h. 2. Trees 60-89cm d.b.h. 3. Trees ≥90cm d.b.h.
Kayu Nyeliwai	*Quercus argentea (Fagaceae)*	Timber for shingles	All trees ≥30 cm d.b.h.

Table 3-7: Forest resources chosen for the Semambu inventory

Jambi Dialect name	Latin name	Uses	Information required
Sialang	Canopy emergents (many species)	Honey from hives	All trees ≥50 cm d.b.h.
Kayu Kulim	*Scorodocarpus borneensis* and *Ochanostachys amentaceae (Olacaceae)*	Timber for construction and fruit for food	1. Trees 10-49 cm d.b.h. 2. Trees ≥50 cm d.b.h.
Kayu Tembesu	*Plectronia dydima (Rubiaceae)*	Timber for construction	1. Trees 10-49 cm d.b.h. 2. Trees ≥50 cm d.b.h.
Kemenyan	*Styrax benzoin (Styracaceae)*	Resin for smoking	Trees ≥5 cm d.b.h.
Durian	*Durio spp. (Bombacaceae)*	Fruit for food	1. Trees 5-29 cm d.b.h. 2. Trees ≥30 cm d.b.h.
Bedaro	*Nephelium eriopetalum* and *Paranephelium nitidum (Sapindaceae)*	Fruit for food	1. Trees 5-29 cm d.b.h. 2. Trees ≥30 cm d.b.h.
Petai	*Parkia spp. (Fabaceae)*	Seed for food	1. Trees 5-29 cm d.b.h. 2. Trees ≥30 cm d.b.h.
Cempedak	*Artocarpus spp. (Moraceae)*	Fruit for food	1. Trees 5-29 cm d.b.h. 2. Trees ≥30 cm d.b.h.
Salak	*Salacca spp. (Palmae)*	Fruit for food	All clumps
Lipai	*Licuala spp. (Palmae)*	Leaves for hat and basket making	All clump
Bambu Mayan	*(Graminae)*	Stems for fence, tool and, raft building and construction	All clumps with stems
Bambu Mumpo	*(Graminae)*	Stems for fence, tool and, raft building and construction	All clumps with stems
Rotan Sego	*Calamus caesius (Palmae)*	Cane for construction and household items	All clumps with stems
Rotan Udang	*Korthalsia echinometra (Palmae)*	Cane for household items	All clumps with stems
Rotan Jerenang	*Daemonorops propinqua and D. didymophylla (Palmae)*	Seed skin gives red dye with international market value	All clumps with stems
Pasak Bumi	*Eurycoma longifolia (Simarubaceae)*	Root for medicinal tonic	Shrubs

Table 3-8: Precision and accuracy of the data from the Long Tebulo inventory

Resource Name	Precision					Accuracy								
	Mean Plants per ha	*Conf Limits* Plants per ha	*CL/Mean %*	*CL/Mean %* if n = 2500	*CL/Mean %* if n = 10000	*1st Check*			*2nd Check*			*3rd Check*		
						Orig	*Check*	*Diff*	*Orig*	*Check*	*Diff*	*Orig*	*Check*	*Diff*
Sekau	20.63	±4.01	19.5	7.3	3.6	8	5	**3**	65	13	**52**	0	16	**16**
Bekai Lanya	0.06	±0.09	164.5	61.3	30.6	0	0	**0**	1	0	**1**	0	0	**0**
Bekai Lan	3.98	±1.74	43.9	16.3	8.2	7	10	**3**	0	0	**0**	0	0	**0**
Sang	12.68	±4.31	34.0	12.7	6.3	8	22	**14**	0	0	**0**	22	75	**53**
Da'a	2.07	±2.78	133.9	49.9	24.9	51	2	**49**	0	1	**1**	0	0	**0**
Wai Seka	1.84	±0.98	53.3	19.8	9.9	0	0	**0**	0	0	**0**	0	1	**1**
Temaha	12.05	±3.73	30.9	11.5	5.8	15	3	**12**	0	0	**0**	4	11	**7**
Merang	0.06	±0.09	164.5	61.3	30.6	0	0	**0**	0	0	**0**	0	0	**0**
Tenak	6.86	±1.23	18.0	6.7	3.3	8	3	**5**	9	14	**5**	8	3	**5**
Kapun	2.36	±1.25	53.0	19.8	9.9	0	0	**0**	0	0	**0**	4	4	**0**
Tumu	0.12	±0.13	116.2	43.3	21.6	0	0	**0**	0	0	**0**	0	0	**0**
Pung Ubi	0.69	±0.35	50.6	18.9	9.4	0	2	**2**	0	0	**0**	2	0	**2**
Nyeliwai	7.49	±1.47	19.7	7.3	3.7	21	4	**17**	0	3	**3**	5	2	**3**

Table 3-9: Precision and accuracy of the data from the Semambu inventory

Resource Name	**Precision**					**Accuracy**								
	Mean: Plants per ha	*Conf Limits: Plants per ha*	*CL/Mean %*	*CL/Mean %* if n = 2500	*CL/Mean %* if n = 10000	*1st Check*			*2nd Check*			*3rd Check*		
						Orig	*Check*	*Diff*	*Orig*	*Check*	*Diff*	*Orig*	*Check*	*Diff*
Sialang	2.38	±0.43	18.0	11.4	5.7	19	9	**10**	2	6	**4**	4	4	**0**
Kemenyan	4.55	±0.86	18.9	11.9	6.0	8	4	**4**	25	0	**25**	0	1	**1**
Kulim	12.38	±1.33	10.7	6.8	3.4	22	0	**22**	20	0	**20**	19	5	**14**
Tembesu	3.85	±0.72	18.6	11.8	5.9	24	2	**22**	17	3	**14**	1	0	**1**
Durian	5.29	±0.86	16.3	10.3	5.1	12	14	**2**	31	0	**31**	2	1	**1**
Bedaro	9.10	±1.47	16.2	10.2	5.1	34	132	**98**	14	3	**11**	0	0	**0**
Petai	3.69	±0.58	15.8	10.0	5.0	3	5	**2**	10	1	**9**	15	5	**10**
Cempedak	1.56	±0.34	21.9	13.9	6.9	1	0	**1**	2	0	**2**	0	1	**1**
Pasak Bumi	18.82	±1.63	8.7	5.5	2.7	36	24	**12**	20	24	**4**	60	86	**26**
Lipai	94.63	±11.77	12.4	7.9	3.9	7	11	**4**	27	43	**16**	370	440	**70**
Salak	3.79	±1.12	29.6	18.7	9.3	4	3	**1**	0	0	**0**	3	2	**1**
Bambu Mayan	1.28	±0.60	47.1	29.8	14.9	31	30	**1**	0	0	**0**	1	1	**0**
Bambu Mumpu	7.82	±2.51	32.2	20.3	10.1	153	164	**11**	0	0	**0**	0	0	**0**
Rotan Sego	2.77	±0.81	29.1	18.4	9.2	248	3	**245**	0	3	**3**	3	2	**1**
Rotan Udang	10.70	±2.31	21.6	13.6	6.8	178	3	**175**	1	2	**1**	42	17	**25**
Rotan Jerenang	10.68	±1.95	18.2	11.5	5.8	174	30	**144**	1	189	**188**	2	10	**8**

3.6 MEASURING AND MODELLING NATURAL DISTURBANCES IN NEW YORK STATE

The study compares and contrasts the impacts of a large-scale natural disturbance and the impacts of selective timber harvesting on focal fauna and flora of mixed northern hardwood – spruce forests in Adirondack Park, New York (Fimbel and Fimbel 1997). Lessons learned from response of the biological community to the natural disturbance will be translated to recommendations for silvicultural practices which minimise differences between the natural (windstorm) and anthropogenic (logging) disturbance regimes.

Case Study Synopsis

Area of Concern: Adirondack Park, New York, USA. The Adirondacks are a 6 million acre (2.4 million ha) reserve comprised of totally protected lands interspersed with managed, private forest holdings.

Problem: A paucity of information to promote the conservation of biodiversity within mixed northern hardwood-spruce forest types targeted for sustainable forest management.

Organization/Infrastructure Created: Research team from Wildlife Conservation Society.

Methods: Variety of schemes to sample both flora and fauna.

Results: Data were collected and analyses are in progress.

The study program addresses the following specific aims:

1. To provide baseline data to assess similarities/dissimilarities in the composition of the flora and fauna of virgin old growth forests subject to periodic landscape-scale natural disturbances and lands managed for timber production;

2. To identify silvicultural practices that mimic natural disturbance and maximise the conservation of biodiversity across the landscape, while remaining sensitive to economic considerations.

3.6.1 Project Design and Methodologies

To meet the first specific aim described above, the following experimental design and field sampling methods have been employed. The recommendations for silvicultural prescriptions, as indicated in specific aim #2, are subject to the identification of significant differences between old-growth and managed stands of similar seral states (to be derived from specific aim # 1)

3.6.1.1 Experimental Design

Within the western Adirondacks of New York, 12 hardwood-spruce sites were identified for field data collection: 6 in the virgin old-growth Five Ponds Wilderness Area, and 6 sites in production forests on private property. See Figure 3-12. The study plan includes 3 stands (replicates) in each of the following 4 'treatments': 1) old-growth, not blown down; 2) old-growth, with moderate blow down; 3) production forest nearing 'maturity' and slated for selective timber harvest in 1998; and 4) production forest nearing 'maturity' that will not be selectively cut for the duration of the study. The four sites in treatment #3 will convert to 'post-harvest' sites in subsequent years of the study.

Nested within each 20 acre (8 ha) study site, are replicated flora and fauna sub-plots. Each site is visited two times per year, first in late spring, and then again in mid-summer. Data have been collected using standardised methods applicable to studies in the region, on the following taxa: trees, shrubs, herbs, grasses, bryophytes and above-ground fungi (flora group); and, large mammals, small mammals, herpetofauna, birds, ground beetles, and spiders (fauna group). Characteristics of the habitat, including cover, soil types, slopes, and aspects, were also noted. A detailed description of the field sampling methods, which began in the spring of 1997, appears below.

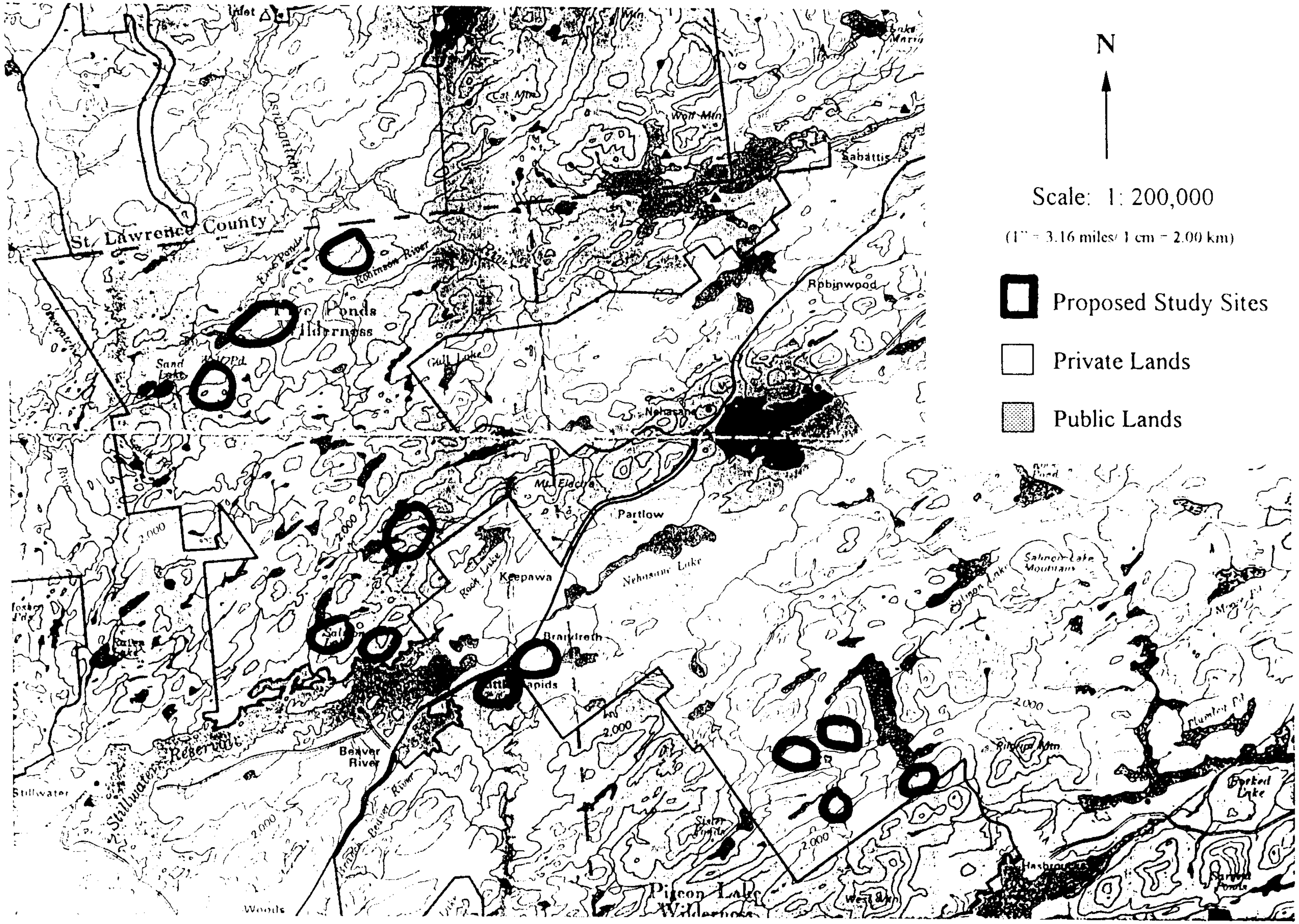

Figure 3-12: Location map of the Adirondack Park study area.

3.6.1.2 Field Data Collection Protocols

See Figure 3-13 for sampling layout and Figures 3-14 and 3-15 for sample forms.

Vegetation Plots - Vascular Plants: A series of overstory, understory, and regeneration sample plots are nested within each study site. Twenty circular overstory plots, 0.125 acres (0.05 ha) each, were systematically located across the area at ca. 200 foot (60 m) intervals. On sloping terrain, plots were corrected to a horizontal dimension. Within each of these plots, all stems greater than 4 inches (10 cm) d.b.h. were measured and permanently marked using aluminium tags. Variables noted on each tree included: 1) diameter; 2) canopy position; 3) estimated height; 4) general health (following guidelines in Allen *et al.* 1992); and 5) den site availability. Plot centres were permanently staked, and physical attributes noted (slope, aspect, proximity to streams, gaps, etc.).

Sapling stems, 0.25-4 inches (1-10 cm) d.b.h., were measured within 40-0.025 acre (0.01 ha) circular plots per site. Half of the plots were established within the 20 overstory plots, with the balance located between them. Sapling parameters measured include: 1) diameter; 2) estimated height; and 3) general health. Coarse woody debris (CWD), ≥4 inches (10 cm) in diameter, were measured and classified within each plot following protocols described by Tyrrell and Crow (1994). Finally, canopy closure over the plot was quantified using a point quadrat method (Greig-Smith 1983). Canopy cover at four height classes (0-7, 7-33, 33-66, 66+ feet or 0-2, 2-10, 10-20, 20+ m) was measured for 60 points distributed across each plot.

Regeneration was measured within 80-10.75 ft^2 (1 m^2) circular plots; two nested within each sapling plot. Seedlings of woody species <0.4 inches (1 cm) d.b.h. were recorded by 0-1, 1-3, 3+ foot (0-30, 31-90, 91+ cm) height classes. General health and evidence of animal browse were noted. The percent ground cover by herbaceous species, rock, soil, and litter in the plot, were also recorded. Where the identification of a species was in question, voucher specimens for that species were collected from outside of the regeneration plots. Regeneration plots were sampled two times/year; once for spring ephemerals (mid-May to mid-June), and again in mid-summer (early July to mid-August).

Above-ground Fungi & Bryophytes: Systematic surveys using a standard measure (counts, frequency, or biomass) during different parts of the season (and preferably over several years) are required to fully characterise fungal communities at different sites (Pilz and Molina 1996). Fungi are planned to be sample 2-3 x during the 1998 growing season, using macro-characteristics (fruiting bodies and mycelium), within all CWD plots. The percentage cover by bryophyte species was assessed one time during the spring growing season, in all regeneration plots.

Data from the vegetation surveys are being used to develop density (basal area and stems per acre/hectare for woody species), percent cover (herbaceous vascular plants and bryophytes), and measurements of ecological diversity (diversity and similarity indices for all plant groups), for use in comparisons of similarities/differences between 'treatment' areas.

Large Mammals: Line transect sampling between vegetation plots was employed to record large mammal sign (primarily deer, rabbit, and other large mammal dung), and live animal observations of deer, rabbits, squirrels, etc. The length of transect sampled per study site varied between 0.75-1.0 mile (1.2-1.6 km), depending upon the configuration of vegetation plots in the study site. Transects were walked at an average speed of 1 km/hr, adhering to the general guidelines for line transect sampling described by Burnham *et al.* (1980), Barnes and Jensen (1987), and Rudran *et al.* (1996). Data recorded for each observation included: time of day, distance along transect, perpendicular distance from transect to animal or sign observed, and direction of travel if the observation was a live sighting. Data are being used to calculate relative abundance of animals or sign per study site.

Small Mammals: The composition of the small mammal community was evaluated using Sherman live traps to capture small terrestrial mammal fauna such as rodents and insectivores. Parallel trap lines, approximately 540 feet (165 m) in length, were located in the central core area of each study site. Two large size Sherman traps (9"x 3.5"x 3"/ 23cm x 9cm x 7.5cm) were placed at each trap station, and stations were spaced 50 feet (15 m) apart along the 2 census trap lines for a total of 50 trap stations (100 traps) per study site. Traps were placed on the ground along natural features such as fallen logs or runways, but avoided sites with potential for flooding. Traps were baited with a mixture of peanut butter and rolled oats, and remained open for three consecutive nights. A fibre wadding was placed inside the traps to provide bedding and insulation for captured individuals. All traps were checked either one or two times daily, depending upon initial capture composition (where shrews were captured, traps were checked two times daily because these insectivores were at risk of mortality due to their exceptionally high metabolism). Each study site was sampled one time (equal to a period of 3 consecutive days) during the summer sample period. This yielded a total of 300 trap nights per study area. Although this number falls short of the 500 trap-night minimum recommended by Jones *et al.* (1996), when all three replicate stands of a single treatment (see overall study design) are considered together, this yielded data from 900 trap-nights to describe the small mammal fauna for a given treatment.

Captured animals were transferred to plastic bags to facilitate weighing and body measurement procedures, along with general observations of specific anomalies. Animals were identified to species with the aid of field guides, recording information on age and sex categories and breeding condition. Each animal was removed from the plastic bag by gripping the nape of the neck. The animal were marked by a dorsal fur clip (cutting dorsal fur in one of 6 places) which did not harm the animal in any way, and subsequently released.

<u>Bird Community</u>: There is a wide variety of field methods described for monitoring land birds, but point counts are the most efficient and data rich method of counting birds (Ralph *et al.* 1993). Point counts are most effective for passerine birds during breeding periods, but do not generally provide reliable data for quiet birds, large soaring birds such as hawks, nor waterfowl.

The composition of the bird communities in each of the study stands was evaluated using fixed-radius intensive point counts. Each stand contained 4 points, or sampling stations. Following the standardised recommendations outlined in Ralph *et al.* (1995), an experienced observer recorded the identification of all birds seen and heard within a radius of 164 feet (50 m) onto a point location mapping data sheet. The observer spent 15 minutes at each point, and separated data for birds detected during segments of 3 min., 2 min., 5 min. and 5 min. (= 15 minutes total). Birds detected at distances greater than 164 feet (50 m) from the observer but within the study site were recorded separately. Points were systematically located with a random starting point, and separated by a distance of 656 feet (200 m) to minimise repeat countings of the same species. All points were located at least 165 feet (50 m) from the stand border. Point counts were conducted within five hours of dawn, generally 05:30 h to 10:30 h, during the diel period of maximum vocal activity. Samples were not conducted during severe wind or rain storms when vocalisations or observations may be obscured by rustling leaves. Each stand was sampled twice early in the breeding season (mid-May to mid-June), and twice during the late breeding season (late June to mid-July) to maximise opportunities for recording all breeding birds, regardless of their time of breeding.

<u>Herpetofauna</u>: Sightings of reptiles and amphibians during visual encounter surveys along transect lines, and leaf-litter quadrat searches, were used to describe the herpetofauna community at each study site. Sites were sampled two times during the summer field sampling period.

- Visual Encounter Surveys: As a refinement of the visual encounter surveys described in Heyer *et al.* (1994), the line transects described for large mammals above were used for sampling herpetofauna. One observer walked 0.75-1.0 mile (1.2-1.6 km) of transect line in each study site, recording observations of amphibians and reptiles, especially frogs and toads, seen from the transect line. This procedure included searches within and under CWD one meter to either side of the transect. By sampling a straight line of measured distance, the data obtained allows comparison of relative abundance and species composition between treatment areas.

- Leaf Litter Quadrats: Twenty square leaf litter quadrats, 9.85ft x 9.85ft (3m x 3m) in size, were placed in a systematic random array in each study site, in close proximity to the vegetation plots. This quadrat size represents a compromise between the large 26.3ft x 26.3ft (8 m x 8m) and small 3.3ft x 3.3ft (1 m x 1 m) quadrats recommended by Heyer *et al.* (1994). Although the larger size is preferred, use of this large quadrat is constrained in the Adirondacks by relatively uneven terrain, and the limits imposed by a field crew size of only two individuals. Two field technicians recorded the starting time, and then begin to search slowly through leaf litter and ground detritus, sifting through the layers to locate amphibians, especially salamanders. A general sweep was conducted by each technician on their respective side so that layers of leaf litter are brushed from inside the plot to the outside, for example, from in front of the technician, to behind him/her. When animals were located, they were captured and immediately transferred to a plastic bag. When the two technicians finish, the end time was noted and the captured individuals were identified, measured, weighed, and subsequently released.

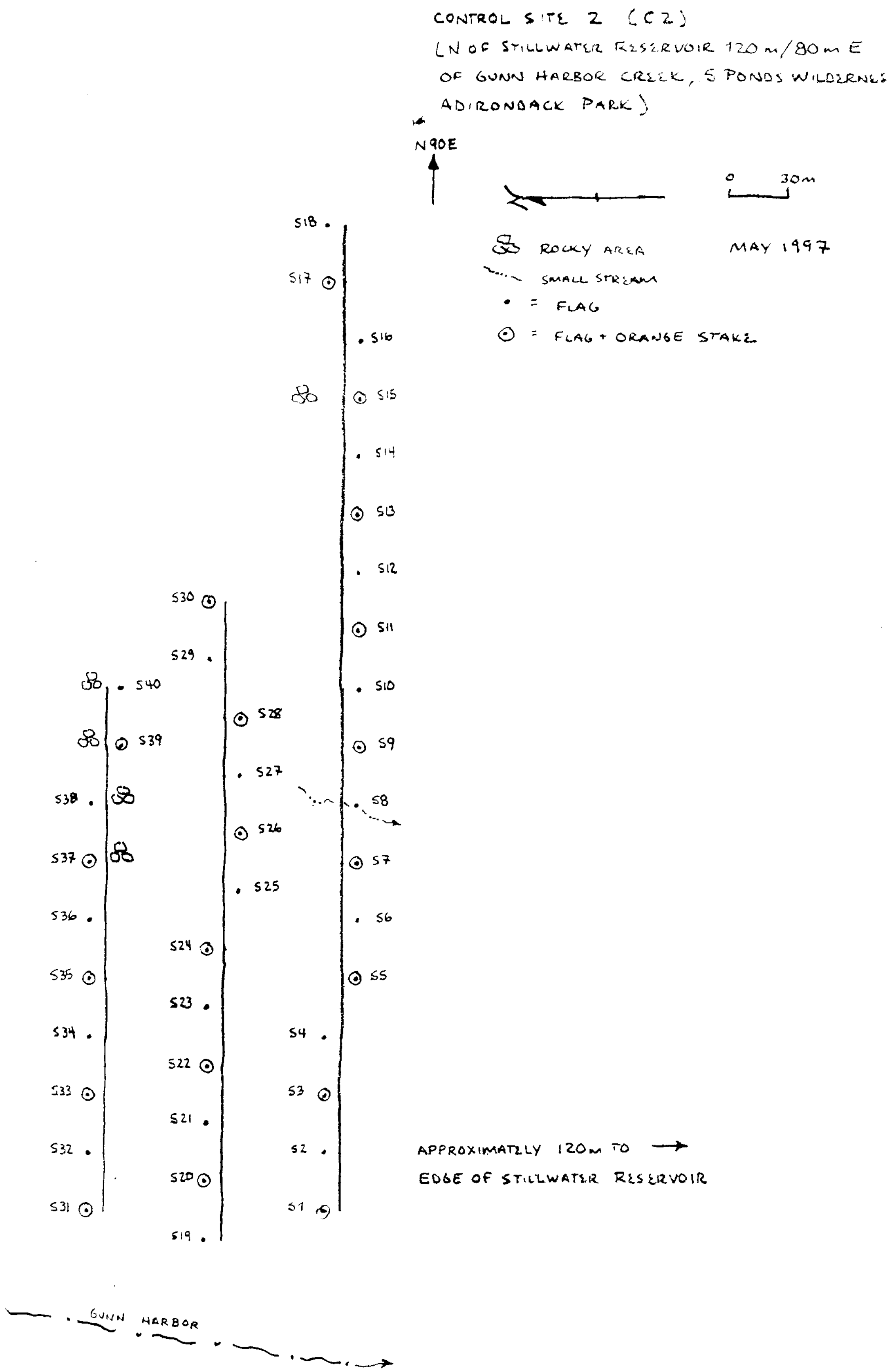

Figure 3-13: Example transect and plot layout.

ADIRONDACK BIODIVERSITY STUDY **Site:** ____________ **Crew:** ____________
Overstory Tree Plots (12.62 m/41.38 ft radius)

Slope: ____° Aspect: ______ Comments:

Tag #	Species	Diam (cm)	Diam Ht (m)	Stem Angle	Canop Posit	Vigor	Den Qual	Comments

Slope: ____° Aspect: _____ C

Tag #	Species	Diam (cm)	Diam Ht (m)

ADIRONDACK BIODIVERSITY STUDY **Site:** ____________ **Date:** ____________
Understory Sapling Plots (5.64 m/18.51 ft radius) **Crew:** ____________

Plot:

Species	Diam (cm)	Diam Ht (m)	Stem Angle	Vigor	Comments

Plot:

Species	Diam (cm)	Diam Ht (m)	Stem Angle	Vigor	Comments

ADIRONDACK BIODIVERSITY STUDY **Site:** ____________ **Date:** ____________
Regeneration Plots (0.56 m/1.85 ft radius) **Crew:** ____________

				Cover			Seedlings			
T	R	P	Q	Species	%Cov	Comments	Species	Ht	#	Browse

				Cover			Seedlings			
T	R	P	Q	Species	%Cov	Comments	Species	Ht	#	Browse

ADIRONDACK BIODIVERSITY STUDY **Site:** ____________ **Date:** ____________
Down CWD Plots (5.64 m/18.51 ft radius) **Crew:** ____________

Trmt	Rep	Plot	Species	Sm Dia (cm)	Lg Dia (cm)	Lenght (m)	Decay	Comments

Trmt	Rep	Plot	…	ments

WCS AP Blowdown-Biodiversity Study

Site:	Date:
Trmt: Rep:	Plot: Quad:

Habitat:

Form:
type: woody / herb / fern-grp size (cm): ______
form: upright / trailing stem: single / multiple

Leaves:
arrangement: alternate / opposite / sub-opposite
form: simple / compound / whorled / basal
compound: imparipinnate / paripinnate leaflets: ______

Twig:
spines: stipules: bt: odor:

Flowers:
form: regular / irregular
stamen: #: ____
pistil: superior / inferior chambers: ______
petals: #: ____ color:
sepals: #: ____ color:

Fruits:
arrangement: size (cm): ______
color: seeds:

Name: Common:
Family:
Genus/Species:
WCS Adirondack BBS#

ADIRONDACK BIODIVERSITY STUDY **Site:** ____________
Ground Cover Transects (10m @ 0.1m intervals) **Crew:** ____________
Treatment: _____ **Replicaton:** _____ **Plot:** S_____

Transect __________

Species of Vegetation Observ.

Dist. (m)	0.5 - 1.0m	0.3 - 0.5m	0 - 0.3m	Grnd cond.	Dstrb class	Comments
0.0						
0.5						
1.0						

Transect _____

Species of

Dist. (m)	0.5 - 1.0m
0.0	
0.5	
1.0	

Adirondack Biodiversity Study **Site:** ____________
Canopy Cover Plots (50 point-samples/sapling plot)

Plot: ____________

Ht(m)	Ctr	45^0 (NE)	2…(SW)
20+	_	_ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _
10-20	_	_ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _
2-10	_	_ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _
0-2	_	_ _ _ _ _ _ _ _ _ _	_ _ _ _ _ _ _ _ _ _

Maximum gap size (2+ m high): ______m^2 (10+ m high): ______m^2 Comments: ________

Figure 3-14: Portions of the vegetation data forms.

WCS Transect Data Summary

1997

Observers:	Date:	Transect location:
Habitat: Wilderness or Private	Blow-Down or Intact	Transect length:
Time Begin:	Time Finish:	Weather:

SIGN

Distance	Species	Sign	Age	P/dist	Habitat	Comments

WCS SMALL MAMMAL TRAP DATA SUMMARY
1997

Observers:

study plot # (1-12)	W[illegible] or P[illegible]	B-D or I[illegible]	Date	night weather	trap #	species	recapture?	age	sex	mass total	mass bag	mass net	bod len	tail len	Comments

WCS Bird Summary Data Form - 50 m radius points 1997

OBSERVER:

study plot # (1-16)	Wild or Priv	B-D or Intac	Date	point #	Time	Species	< 50 m 0-3 min	< 50 m 4-5 min	< 50 m 6-10 min	< 50 m 11-15 min	fly- overs 0-3 min	fly- overs 4-5 min	fly- overs 6-10 min	fly- overs 11-1 min	> 50 m 0-3 min	> 50 m 4-5 min	> 50 m 6-1 min	> 50 m 1-1 min

Herpetofauna Transect Summary

WCS Adirondack Biod., 1997

Observer(s):_______________

month	day	Study Area	Wild. or Private	30 m segment	rock	wood	species	found in r or w

Figure 3-15: Portions of fauna data collection forms. WCS stands for Wildlife Conservation Society.

Basic habitat parameters were also be noted, including slope, cover, air temperature, soil moisture, depth of leaf litter, and special features in or near the plot such as streams, spring seeps, rock outcrops, etc. Litter was redistributed across the disturbed site at the close of the search. These data are being used to describe the species composition and estimate the absolute density of the more common amphibians in each study site.

Ground Beetles and Spiders: Ground beetles and spiders can be captured readily in pitfall traps arrayed across the forest floor (Bell 1990). Based on our conversations with Dr. Ross T. Bell, a noted Carabidologist at the University of Vermont, we constructed five trap sets, each consisting of five pitfall traps within each of the 12 - 8 ha stands studied. The pit traps were small, clear, disposable plastic "martini" glasses, which can be purchased inexpensively at local supermarkets. For each pitfall, a small hole was dug in the ground so that the lip of the cup was level with the ground surface. A second cup was then nested within the first and filled with 1 inch (2.5 cm) of water to which a few drops of formalin were added. The formalin was added to discourage omnivorous mammals from eating the contents of the traps and to kill the captured invertebrates quickly and prevent them from damaging other specimens. The trap was overlain with a plastic plate to protect it from flooding by rainfall. Traps were checked weekly for four weeks in mid-summer, at which time the contents were sieved, and captured individuals were deposited into 70% ethanol solution in collection vials for preservation and identification.

3.6.2 Data Analysis

A variety of simple and sophisticated statistical analyses are being used to contrast community structure of the various groups assayed in the different forest treatments. Data from the randomised block design for the study sites are being subjected to Analyses of Variance (ANOVA's) to identify significant differences in plant and animal populations, species assemblages, and habitat parameters between 'treatments' (Chambers and Brown 1983, Zar 1984, Magurran 1988). Of particular interest will be the extent to which community shifts are similar or different among groups, especially between invertebrates and vertebrates, and among herbaceous plants, bryophytes, and fungi. Minimally, we are calculating measures of species richness, diversity, evenness and dominance, and examining relationships among sites and treatments using clustering techniques, multidimensional scaling, and rarefaction techniques (Michaels and McQuillan 1995, Pettersson 1996). Among invertebrate groups, we are also characterising communities or guilds based on body size, dispersal ability, foraging tactic, and special habitat needs. Lastly, our data are being digitised and geo-referenced, and thereby serving as a baseline for future monitoring.

3.6.3 Anticipated Outputs

Comprehensive outputs will be available at the close of the first phase of the study, early in the year 2000. A first progress reports is slated for March, 1998, and will provide summaries and interpretations of data collected during the 1997 field season. The following outputs are related to the two specific aims of the study.

Specific Aim #1: To provide baseline data to assess similarities/dissimilarities in the flora and fauna of virgin old growth forests subject to periodic landscape-scale natural disturbances and lands managed for timberproduction.

- A description of the structure and composition of woody and herbaceous vegetation, fungi and bryophytes, and CWD, for each stand, and summarised at the treatment level.

- A description of the composition and relative abundance of the carabids, araneae, herpetofauna, avifauna, and non-volant mammal communities for each stand, and summarised at the treatment level.

- Estimates of measures of diversity for each stand and treatment category.

- Statistical comparison of taxonomic and community level parameters, including composition and diversity, using indices of similarity, across treatments.

- Analyses of habitat parameters, as an aid to identification of environmental factors responsible for significant differences in the biotic composition between treatments (where differences exist).

Specific Aim #2: To identify silvicultural practices that mimic natural disturbance and maximise the conservation of biodiversity across the landscape, while remaining sensitive to economic considerations.

- An evaluation of current silvicultural practices and their influences on biodiversity, including an assessment of ways to improve the conservation of biodiversity across hardwood-spruce forest landscapes (based upon the above analyses) through the use of silvicultural habitat modification techniques.

☺ This approach of describing and contrasting the dynamic nature of northern forest lands, overcomes biases associated with historical evaluations based on relatively static, mature old growth stands as the standard for comparison with stands managed for timber production. The information generated by this undertaking will provide innovative standards for the assessment and modification of efforts to promote the conservation of biodiversity in sustainably managed forest landscapes.