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THE EFFECT OF FARMING EXPANSION ON HUNTING

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Farming expansion is typically interpreted as a deleterious factor in the persistence of a hunting-gathering lifeway. Data from the Philippines on crop losses to game and hunter perceptions of hunting sites and game habits indicate that game are attracted to crop fields, specifically to field expansion. Because of "edge effect," agricultural expansion may support a higher density of game because of the increase in the linear extent of the ecotone and the particular attractiveness of edge conditions.

Introduction

Most interpretations of the distributions of ethnic and racial groupings in modern Southeast Asia attribute the inaccessibility of contemporary Negrito hunting populations to their displacement from more "desirable" areas by expanding agricultural populations (see e.g., Reed 1904: 14; Steiger and others 1926: 8; Cole 1945: 56; Spencer 1954: 4; Kroeber 1919: 18). It is assumed that as indigenous agriculturalists eliminated forests to open new fields they destroyed the environment upon which hunters and their prey were dependent. In contrast to these interpretations, historic accounts indicate that forests were extensive and game animals abundant at the time of Spanish contact (Blair and Robertson 1903-1909 VI: 204-05; XVIII: 98-99 XXXI: 197; XXXIX: 46-47) and that through deforestation, collection of tribute in timber and hides, and smallpox which killed game as well as humans, the Spanish eliminated vast forested areas and diminished game populations (Blair and Robertson 1903-1909: XVIII: 98-99; XII: 188; XLVII. 292; XLII: 234). Elsewhere (J. Peterson 1977a and b) I have suggested that expanding indigenous agriculture before European contact compensated for the destruction of limited forest areas by expanding the linear extent of the forest-field edge. Areas of indigenous agricultural expansion potentially supported higher densities of game than could the undisturbed forest. Following European contact the traditional environmental system broke down in those areas of major impact as vast areas were cleared and the edge/cleared ratio was reduced to the detriment of "edge effect."

"Edge effect" refers to the attraction of some species of animals to the ecotone, or edge between environmental types (Odum 1959: 278, 280; Dasmann 1964: 75; Allen 1954: 72-74). Edge effect is observed among those species which are dependent on more than one environmental type, species which, for example, feed in one type of environment and sleep or seek cover in another. It is most apparent where environmental disturbance by man is pronounced (Odum 1959: 280-281; Leopold 1938: 131-132). Human activity typically produces a pattern of "edges within an edge" (Odum 1959: 280-281). For example, piecemeal clearing on the edge between permanently cultivated fields and the forest creates conditions which offer, within a limited area, access to forest foods, domestic crops, heavy cover, and broken cover. These are ideal conditions for some game species (see e.g. Liem 1976a and b; cf. Dwyer 1978, for a discussion of the role of human disturbance in developing more extensive habitats for some rat species in New Guinea). If such edges are attractive to game, an expanding ecotone, resulting from expansion of an agricultural area, might compensate for forest destruction (Peterson 1977a and b). A gradually expanding indigenous agricultural population might, therefore, permit a higher density of some of the prey upon which

hunting populations are dependent (cf. Liem 1975: 5-6; 1976: 6-8).

The Palanan bay watershed

The Palanan Bay watershed of Northeastern Luzon, offers suitable conditions for testing this interpretation. The area is inhabited by approximately 10,000 Filipino farmers (Palanans), who grow primarily corn and some rice, and about 800 Negrito hunters (Agta), who hunt mostly pig and deer, and fish in streams and on the reef.[1] In modern times, until World War II, the farming population was concentrated in the lower Palanan River Valley. During World War II Palaneños began expanding up and down the coast and up the river valleys, producing by 1970 what I estimated to be a tripling of the linear extent of the ecotone.

The mean monthly dry season temperature of Palanan is 82 degrees, and the annual rainfall, which falls primarily from September through January, exceeds 254 cm. (Spencer and Wernstedt 1967: 54, 423). Nearly a third of all typhoons which reach the Philippines strike this northeastern coast. The area is characterized by steep hillsides with slopes ranging from 40 to 90 percent, narrow winding river valleys, and triple-canopied dipterocarp forests. The land points of the bay are more barren, with ironwood stands on the northern point, but for most of the coastal area the beach and cultivated vegetation of the coastal plain is supplanted within 300 meters by forest.

Logging, as well as farming, produces large cleared expanses throughout the Sierra Madre range. Logging in that area was relatively limited in scope until the last decade; in the last few years, the logging enterprise has particularly expanded. In 1978, vast areas had been denuded north of Palanan, near Maconacon, and on the western watershed of the Sierra Madre, near San Mariano. Logging in the Palanan Bay watershed has been severely limited by lack of access; all equipment must be imported, and logs exported, by sea. The Palanan logging operation has allowed continuation of residual growth, and has been limited to an area no closer than 60 meters from streams. Areas where logging has occurred in Palanan are indicated in Figure 1. Of these, some logged in the early 1960s are regenerating.

The Agta have observed the impact of major recent clearing on game. They say there are now game trails high in the mountains where previously there were none, and that there are fewer game now than there were several years ago. Relative to this latter claim, it is noteworthy that when asked to compare "good" and "poor" hunting areas when they were children, when they were first married, when their children were young, and now, their reconstructions of "good" areas correlate perfectly with the expanding agricultural ecotone. It appears that "good" hunting in Palanan Agta terms may be a by-product of marked agricultural expansion; the correlation of "good" hunting with the expanding ecotone suggests that what they regard as the best hunting occurs only under conditions of agricultural expansion and initial clearing. Their assessment, therefore, of inferior hunting now may not represent a significantly lowered game population so much as a different distribution pattern for game; that is, the best hunting has followed the agricultural frontier to a new area, and formerly "good" hunting sites, now agriculturally stabilized, are seen as poor by comparison to their own recent history, or to newly cleared areas now.

It is noteworthy, too, that through hunting and trade with farmers, the Agta provide an average of six kilograms/day/person of pig, deer, and fish, to the *entire* population of the Palanan Bay watershed, a remarkable figure in comparison with the estimate of 7.2 kilograms/day/person from *all animal protein sources* in developing nations as a whole (Agency for International Development, 1970;

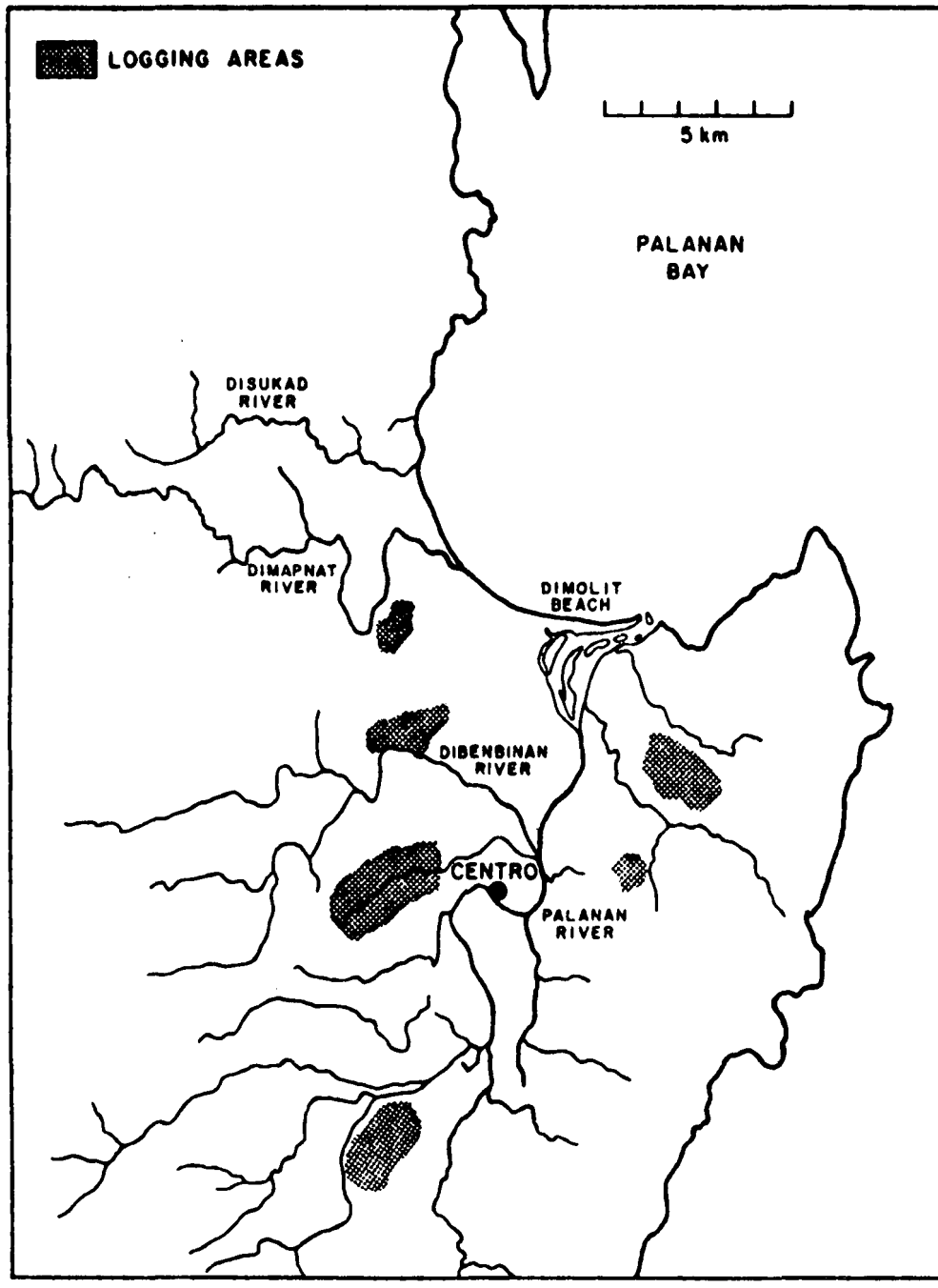

Figure 1. *Logging in Palanan Bay*

for a breakdown of animal protein production by these Negritos, see J. Peterson 1978a and b).[2] Nearly half of the total wild animal protein is provided by game as opposed to fish. It is also significant that the economic and nutritional data collected in 1968 to 1970 indicate that Palanan farmers raise very little domestic protein and acquire a majority of

animal protein from Agta (J. Peterson 1978a: 26-27, 43, 64, 78, 113n; 1978b). In the 1978 study period, I tallied 70 pigs and 30 deers killed by Agta in the study area covering three river drainage systems.[3] It is also significant that in this area, at least, the Agta are clustered on the peripheries of farming settlement, in part because they trade with farmers (J. Peterson 1978b), but also because they hunt extensively on the ecotone, and even in crop fields. Finally, pig and deer are widely recognized there as significant crop pests.

Agta informant perceptions of game feeding habits indicate that game exploit the ecotone and adjacent areas. Agta, who know their prey well, cite domestic and wild fruit as the preferred food of pigs, followed closely by domestic field crops – rice, corn, and a variety of tubers, especially yams and manioc. They also feed on wild roots and worms. Of domestic field crops, they prefer corn and feed on it throughout its season (March through July), but especially from the time the tender ears appear in late April until it is harvested. Farmers lament that among their other faults, pigs are wasteful; they remove mature ears of corn from the plant and often eat only that half which is exposed, leaving the bottom half that faces the soil on which it lays. They consume rice from December through May, and in both kinds of fields destroy many plants by trampling them or rooting in the soil surrounding them. Deer, according to the Agta, feed on leaves and grasses, and to a lesser extent fruits. Of domestic crops they eat rice, corn leaves – especially young leaves in late March, and young ears of corn. On the whole, they are less destructive than pigs, in part because of their feeding habits, and in part because, unlike pigs, they do not herd.[4]

Methodology for collecting crop histories

From May through July, 1978, I collected histories of clearing, crops planted, and corn damage over a period of three and a half decades for one area of the Palanan Bay watershed as one test of game attraction to crop field and/or an expanding forest-field ecotone. I interviewed *every* farmer in that area, a total of 37 farmers on the Dimapnat River and the adjacent coastal areas from the Disukad River to the Dimapnat and from the Dimapnat River mouth south along the Dimolit coastal area to the Palanan River mouth (see Figure 1).

Where clearing was initiated within the past ten years, farmers were able to recount records of crops, yields, and damages in detail. For longer-cleared land, I asked them to recall (1) the first years of clearing and planting, (2) the worst years for crop damages, (3) the time when crop damages noticeably diminished, (4) any unusually high or low crop damage since then, and (5) actual yields and damages for the previous three years. I also collected histories of human habitation on the land, and measures they have taken to minimize game pest damage. Damages short of 100 percent of necessity represent farmers' estimates. Patterns of agreement on crop and damage history emerged, however, permitting identification and correction of discrepant data.

The General history

Characteristically Palanan farmers take over land previously cleared by Agta. Only Agta inhabited the study area until World War II. Some planted tiny gardens, all traded with their nearest farming neighbors. Whether planting or not, they made small clearings on stream banks for camps.[5] Until the 1950s when farmers began moving into the area and Agta could borrow saws, all clearing was done with machetes, and trees with trunks over 10-15 centimeters diameter generally were not cut.[6] The first farmers entered the Dimolit area in 1942. Ten years later the first farmers began clearing on the Dimapnat alongside Agta (Figure 2). Now only two small groups of Agta maintain plots on the Dimapnat; all others have moved their clearings north (cf. J. Peterson 1979).

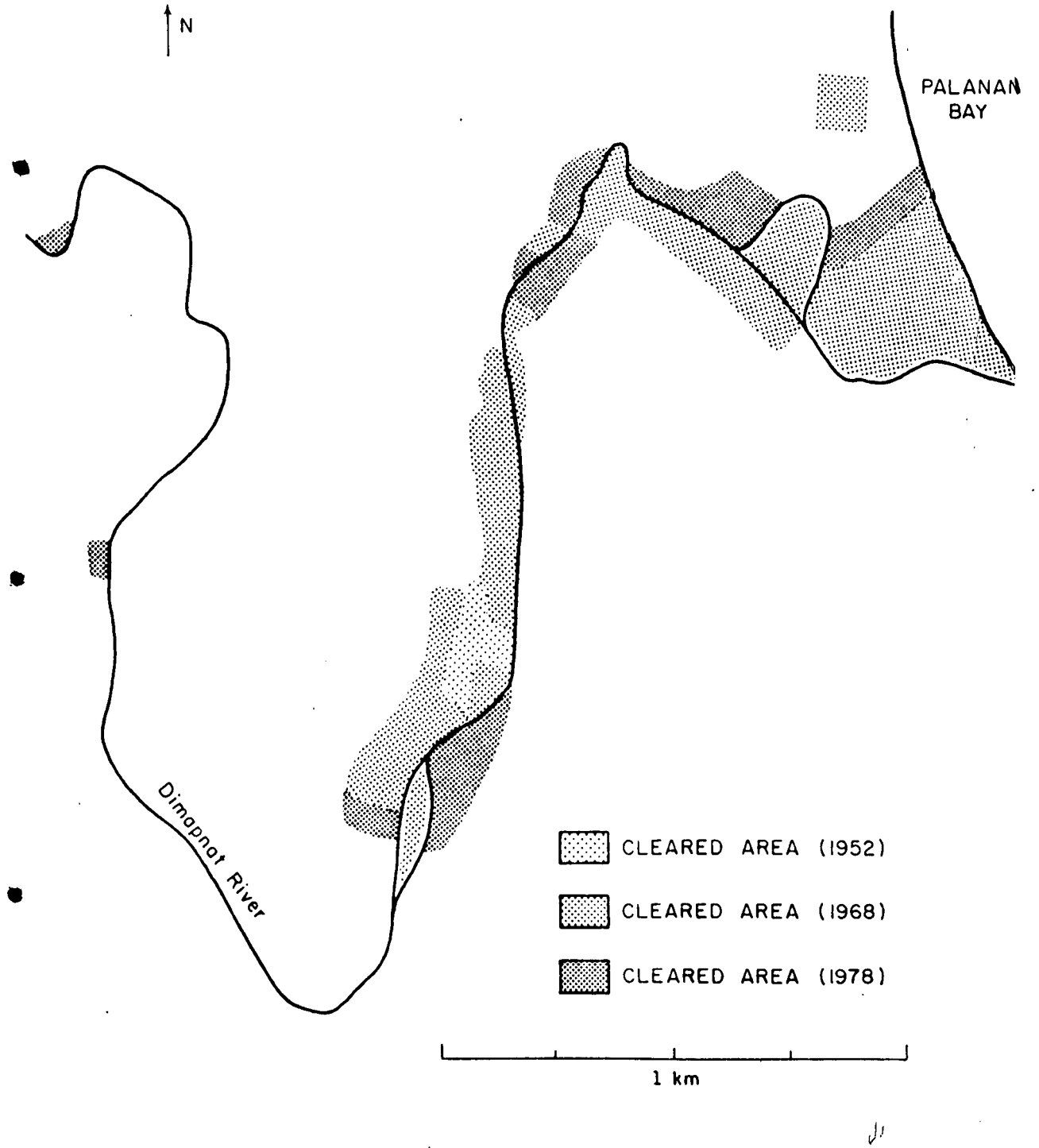

Figure 2. *Ecotons expansion on the Dimapnat River*

Typically, a Palanan farmer moving to new land clears piecemeal, from the coast or river bank. Annually he may clear as much as 1/3 hectare, requiring three to five years to clear his land completely.[7] Large tree stumps are left to rot out, and their presence impedes plowing. As he clears the land, he plants roots and tubers, usually manioc, yams, and taro, which require little tending, but which allow him legally to claim the land as his improved agricultural property. During this initial clearing most farmers maintain homes and plowed fields elsewhere, visiting their new land for only a few weeks out of the year. Agta may actually perform all the labor for them claiming a portion of the crop in payment. As new lands are opened, older fields are often allowed to regenerate to forest growth producing what W. Peterson (ms. in review) has identified as a long cycle system involving initial swidden cultivation, development of permanent fields, then abandonment and forest regeneration. The area studied therefore, exhibits a range of environmental types: various types of permanent fields, mostly rice and corn; new clearing; swidden-type plots planted to a great variety of crops; new fields planted exclusively to roots and tubers; primary and secondary growth.

Specific history of crop damage and clearings

Detailed examination of planting and crop damage history reveal five conditions which appear to affect the attraction of game to the crop fields. These are initial clearing, adjacent new clearing in a stabilized area, placement relative to other cleared areas, human habitation in the area, and deliberate measures to control game damage to crops.

Initial clearing

Farmers typically report 50 to 100 percent crop loss to game damage. In part, this appears to occur because the clearing procedure creates broken cover and a high density of domestic crops, both attractive to game. Once large areas are completely cleared, although the farmer may continue to live elsewhere working his fields seasonally, crop losses drop to around 15 to 20 percent.

Adjacent new clearing in a stabilized area

Even after an area is cleared and stabilized, crop losses to game will increase if an adjacent area is cleared. Thus, one farmer, who cleared and planted his land to rice in 1967 and 1968 reported regular crop losses of about 1/3 until 1972 when an adjacent field was cleared; then his crop losses jumped to nearly 50 percent, dropping eventually to 10 percent by 1974. One family, who placed pig traps at every game trail entering their fields, provided dramatic evidence of this phenomenon. They began clearing their land in 1958, and annually trapped about 50 pigs. In 1963 a logging company established a camp in the area and began clearing an adjacent coastal area for an air strip one kilometer long. The same year a neighbor began clearing his fields. The camp itself – a noisy, lighted, and densely inhabited area – proved a deterrent to game intrusions during this period. In late 1964, however, the logging camp was abandoned, and the neighbor continued clearing. In 1964 and 1965, the neighbor more than doubled the area under cultivation, and the family snared more than 500 pigs in their pig traps. By 1966 the neighbor had removed all broken cover from 2/3 of his fields and began plowing; they killed 100 pigs in their traps that year, and again the following year. In 1968 they killed only 50, and in 1978, by which time the immediate area was more densely settled and cleared, only 10 were killed.

This case illustrates, as well, the other variables affecting game attraction to crop fields.

Placement relative to other cleared areas

Corners of clearing, that is, fields surrounded on two sides by forest, experience continued higher crop damage by game. Fields

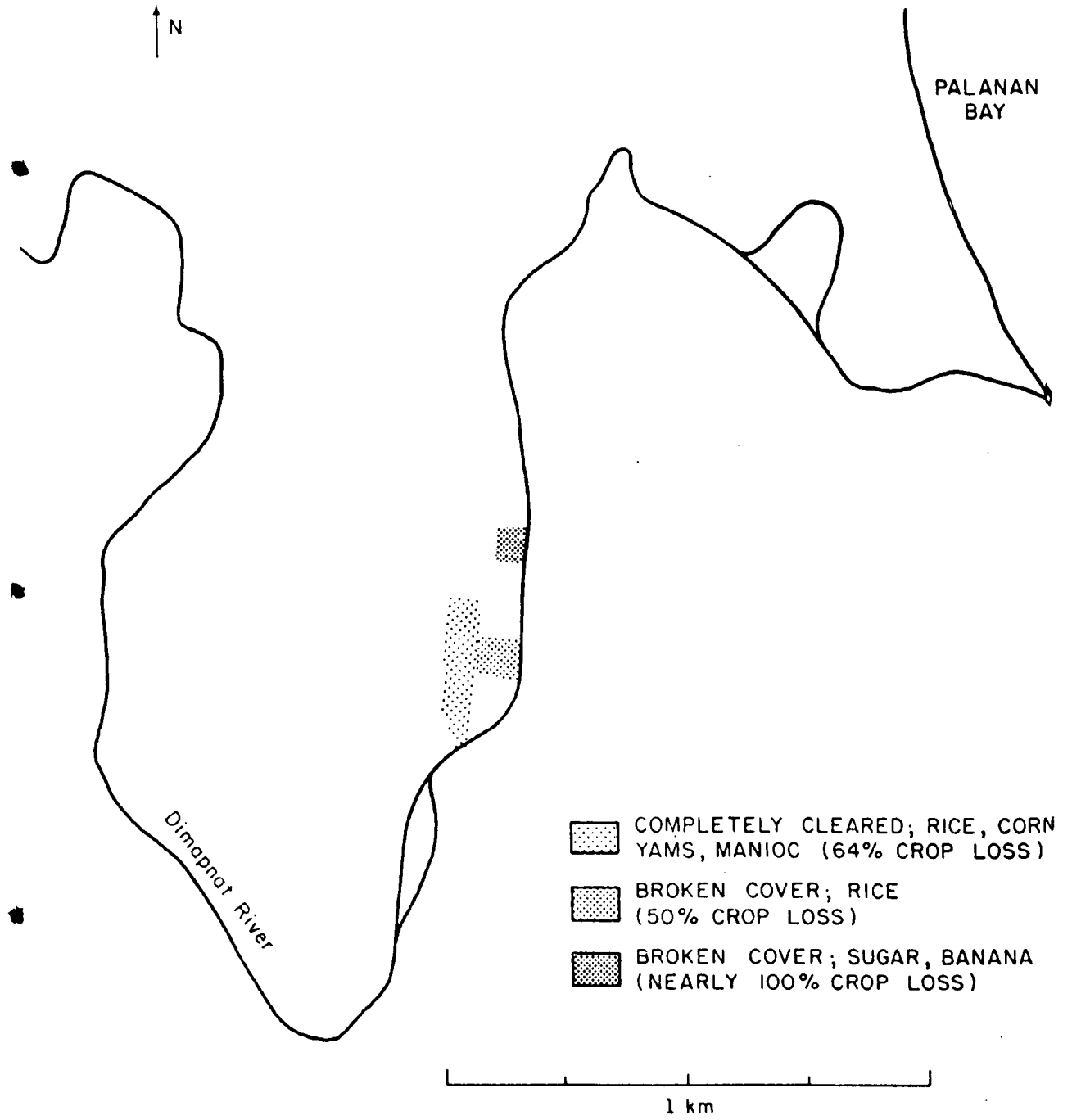

Figure 3. *Clearing and crop losses, 1954*

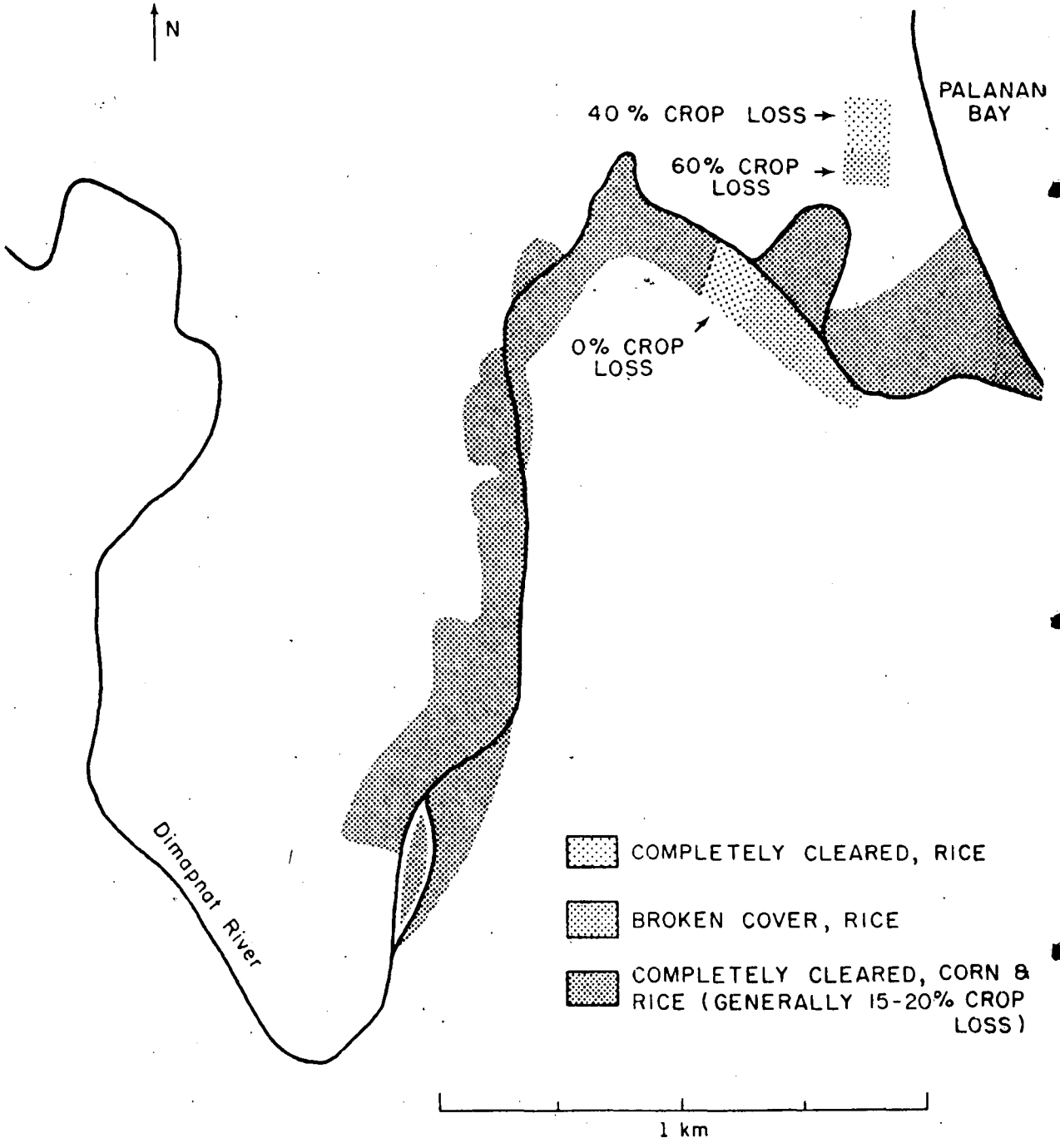

Figure 4. *Clearing and crop losses, 1972*

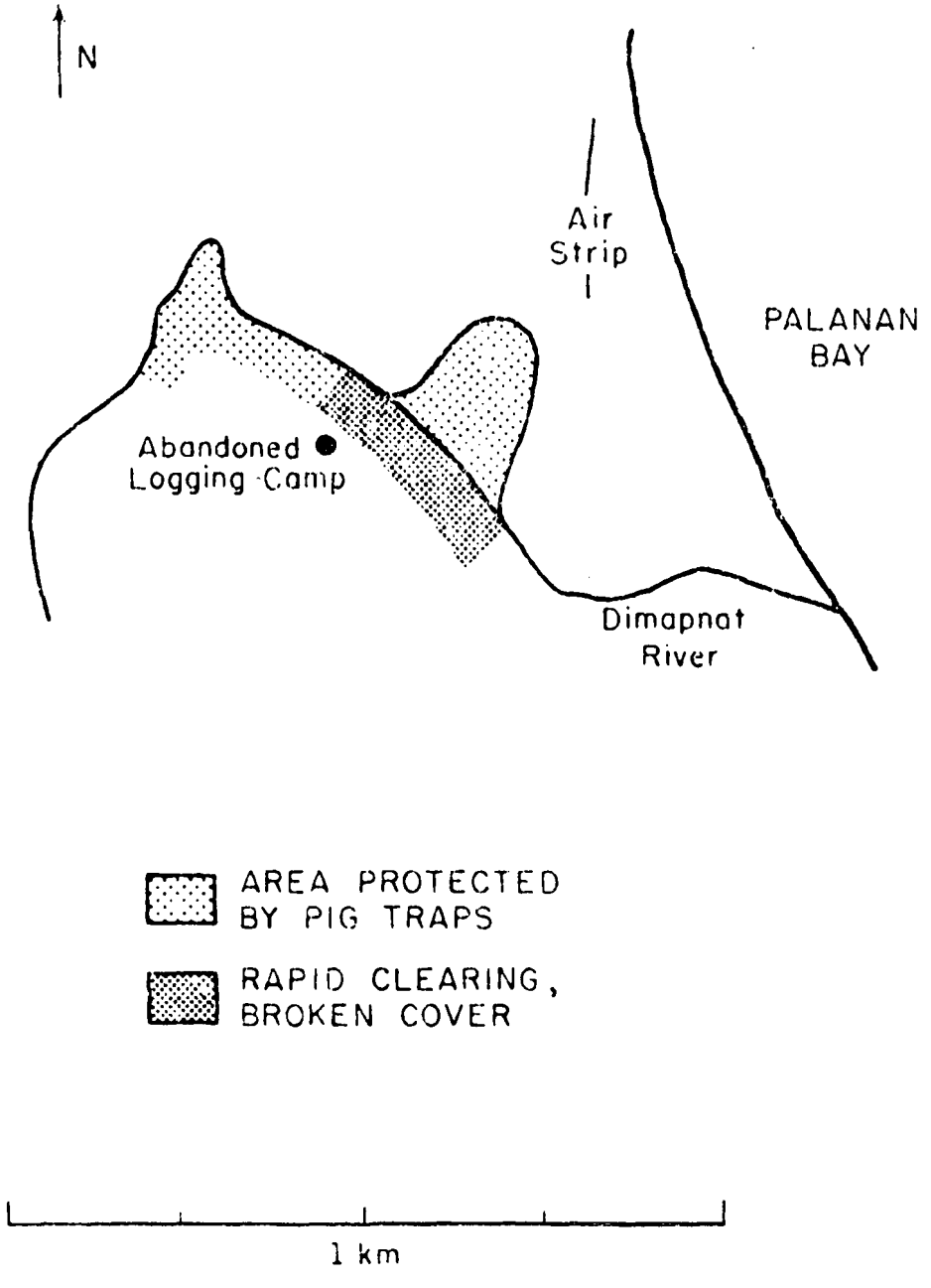

Figure 5. *Area protected by pig traps, 1965*

A and B, completely cleared, plowed and planted since 1968 experience a continued 50 percent crop loss, as compared to adjacent fields completely cleared, plowed, and planted, where only 10 to 15 percent of the annual crop is now lost to game (see Figure 6).

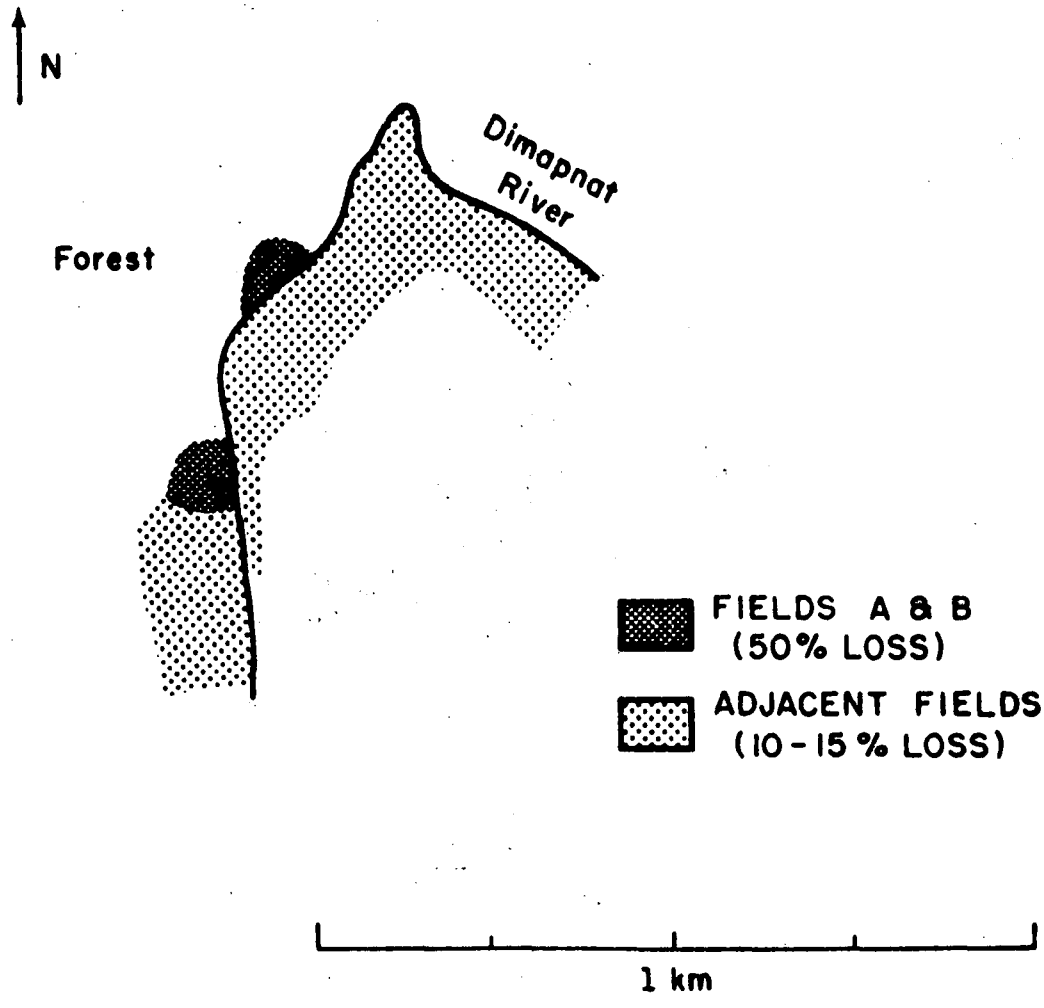

Figure 6. *Exposed fields*

The reverse of this is true, as well; thus fields buffered by other fields experience little or no crop damage (see Figure 7). Field A, first cut in 1958 and fully cleared and cultivated in 1962, never experienced significant loss because fields to the north and west were already well cleared and cultivated. Crop loss ceased altogether after 1970 by which time the fields to the east, across the river, were completely cleared and cultivated. Adjacent farmers, those who cleared first in the same areas, report 60 to 80 percent crop loss to game in the early years, and continue to experience a 10 to 15 percent loss.

Habitation in the area

All farmers report a significant drop in game damage once they take up residence at the cultivation site. Losses will drop from 80 to 100 percent before habitation, to 10 to 20 percent the year someone begins to live there. While farmers tend to regard the presence of houses as the most significant deterrent to game entering fields, several cases suggest that it is the *daily* presence of humans in the fields that actually deter game. There are three cases of farmers, planting in stabilized areas with an annual 10 percent loss, who for one crop

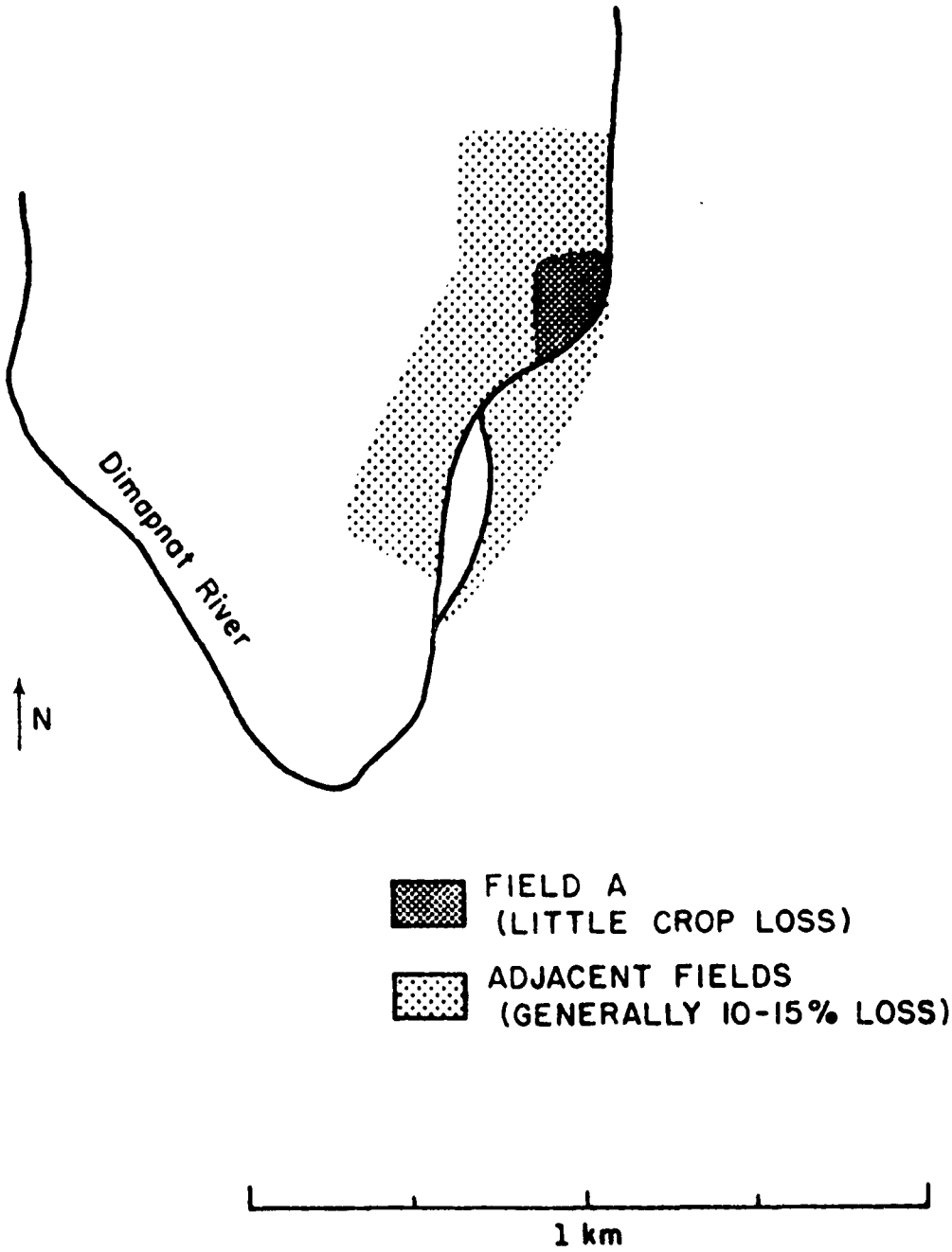

Figure 7. *Buffered fields*

year, planted, left their fields, and returned to harvest. In each case, the wife and children remained in the house, but did not visit the fields regularly; in each case, the crop losses for the year of farmer-absence rose to 80 to 100 percent. The reverse is true, as well. One extended family, the first to clear an isolated tract, began to hold their losses to about 20 percent when their youngest son, an unmarried adult, began visiting the fields

daily, sometimes sleeping over in a temporary hut. Another family, still clearing a "corner" tract in 1978, eliminated their crop losses by posting one member of the family in the field *every* night. The Agta say that pigs can discern human smell in a place for about 24 hours after any human has been there.

Deliberate measures to control game damage to crops

All farmers take measures to keep game out of their fields. In addition to practices already mentioned (pig traps, habitation, and guards), some fence their fields, either all the way around or at least on the forest side. Others place in their fields anthropomorphic figures ("scaregames?") of cloth that flutter in the wind, and one strung tin can lids along the edge of his field to rattle in the breeze. Some tie bits of fluttery white cloth on fences. Many farmers place "bombs" fashioned from match heads concealed in edible roots randomly around their fields and in the adjacent forest. These explode if stepped on or bitten into, and probably injure or frighten more game than they kill. They also deter hunting which might be a better game control measure (W. Peterson ms. in review; J. Peterson 1979). One extended family built their houses on the edge of the forest so that game would have to pass through an area of human habitation to reach their crop fields. All farmers plant their crops in a characteristic pattern designed to minimize damage to staple crops. Fruits, especially bananas, are planted near the forest edge or actually in the forest in one case. Farmers anticipate that pigs will either sate themselves on fruit before passing on to the staple crop fields or, in the case of the banana patch in the forest, that they will be attracted away from crop fields. Less significant staple crops, such as manioc and yams, are forfeited the same way. In other words, they are deliberately feeding the game crops they are willing to lose. Rice is planted next to these, in part because along much of the Dimapnat there is a bog, or intermittent stream at the back of the lowest terrace, suitable for growing rice.[8] Farmers also calculate that damage to rice, even where it is grown in isolated fields surrounded by forest, runs less than damage to corn. My figures indicate that all other conditions being equal, in a stabilized area game damage to rice runs about 5 to 10 percent as opposed to 10 to 15 percent for corn. Corn is planted nearest the river. This yields the following characteristically banded crop pattern:

forest
scattered fruit or root crops
rice
corn
river

The only totally effective crop protection measures appear to be guards, traps at every game trail, and buffering by the plowed permanent crop fields of neighbors. With any other measures, many of them quite labor intensive and even dangerous, farmers continue to lose at least 10 percent of their crop to pig and deer (see Figure 8).

A topographic feature of the narrow Dimapnat River valley is relevant to edge effect in the Dimapnat area (see Figure 9). The Agta observe that one of the feeding sites most attractive to pig is the zone they call "forest on the edge of the mountain" *(katalonan digdig ni bukid)*. They are referring to the base of the steep 50 to 90 percent slopes that rise sharply from the narrow forested terrace behind cultivated fields along much of the Dimapnat River.

Any fruit born on the steeper slopes rolls to this point and pigs can, in some months (predominantly October through December), glut themselves there. This produces one more

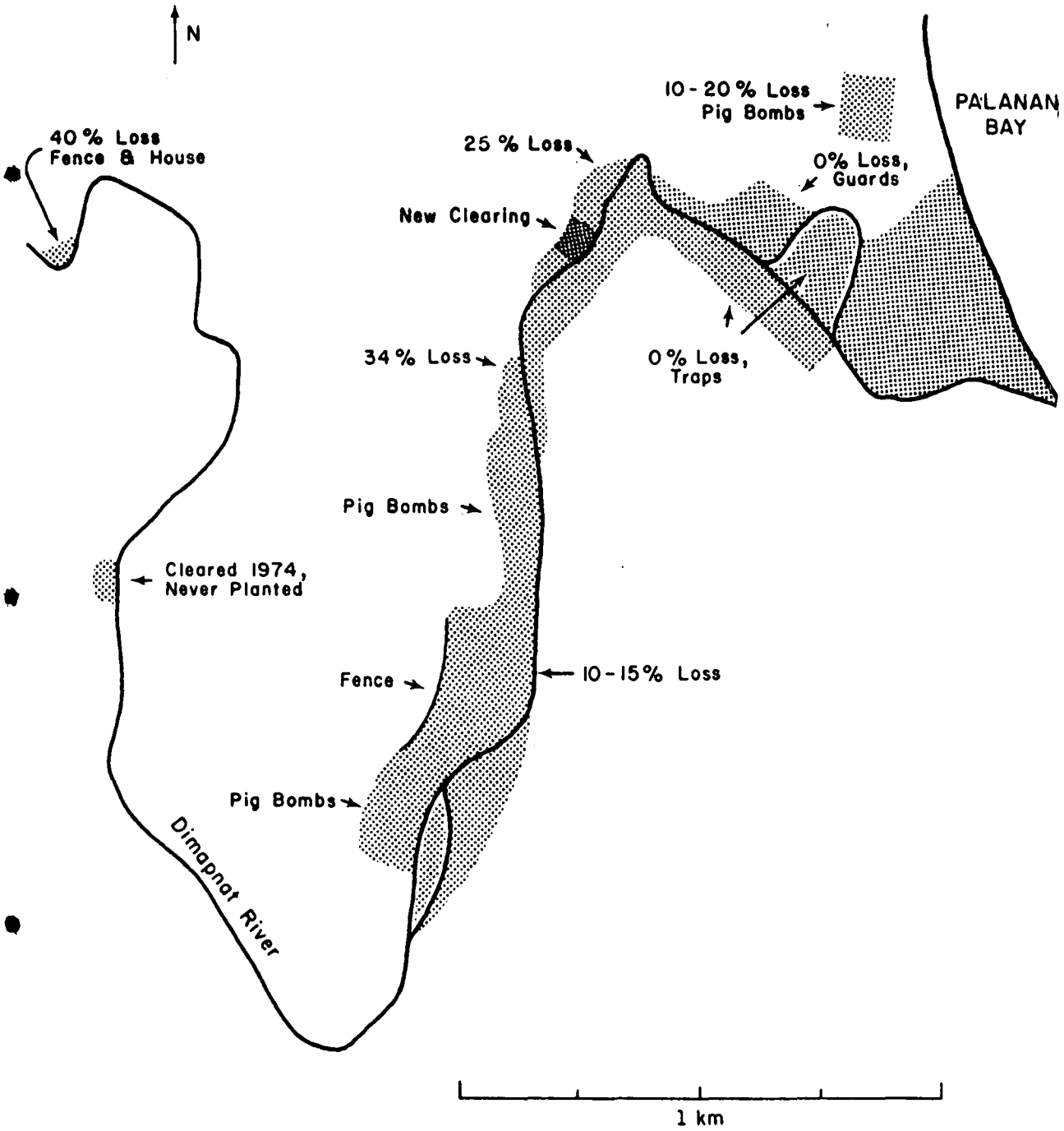

Figure 8. *Crop losses for 1978*

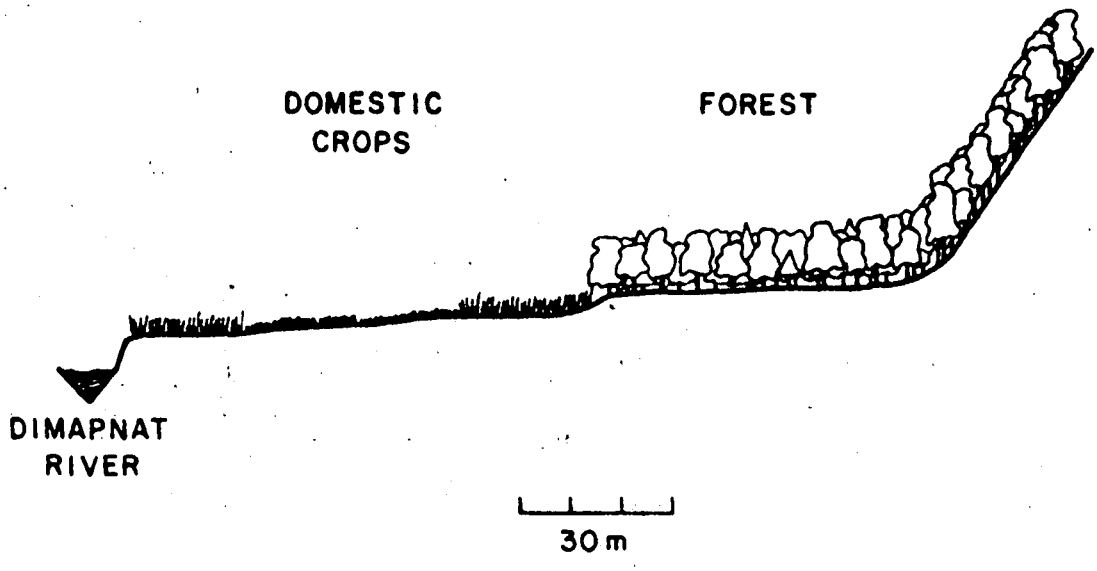

Figure 9. *Topographic profile of Dimapnat River Valley*

attraction area near the crop fields, but one unrelated to the fields themselves, and one which would not apply on other rivers.

The pattern and degree of crop damage reflect the principles of edge effect at work. Crop damage is highest where new edges are being created and reduces as the edges stabilize. The forest itself offers cover, as does a partially cleared field. Game may feed in the forest, on the wild fruits which grow in profusion on the forest edge or in secondary growth, and at night, in the crop fields themselves. As noted, this kind of diversity represents ideal edge conditions for some types of game. What is more, broken clearings which occur during early clearing periods create the "edges within an edge" described by Odum (1959: 280-281) as particularly optimal game environments. Even long cultivated areas continue to support game, in spite of the predation of hunters, and farmers' efforts to deter game.

Conclusion

It appears that edge effect operates because of game attraction to crops, to the broken cover created by new clearing, and perhaps to expansion of the linear extent of the forest-field edge. It seems likely that the higher density of edible foods in crop fields as opposed to forest might offset forest destruction by agricultural clearing in supporting a game population as long as limits are maintained. Sufficient cover must remain to provide protection and variety in diet. Furthermore, vast cleared areas eventually reduce the edge/cleared area ratio. Related to this are optimal patterns of clearing. The Dimapnat River valley offers a narrow terrace suitable for cultivation. This imposes a straight-line clearing pattern which limits edge expansion. A wider terrace, such as that found at some points on the Dibenbenan River in the Palanan area, could produce a much higher edge/clear area ratio, and thus be even more attractive to game. Similarly, the shape of clearings would affect the edge to clearing ratio. Farmers in the study area generally clear straight back from the river to form rectangular fields, with the longest side bounded by the river. Were they to clear in other geometric patterns, the edge to clearing ratio would be altered and game attraction might be affected. We can anticipate, from a

comparison of "corner" and "buffered" fields, that less edge to area cleared would reduce access to cover and/or crops, and consequently lower game attraction and crop damage.

The nature of the created edge is significant as well. Palanan farmers expand their fields piecemeal. Even with a permanent crop established, they push back the forest a few trees at a time, leaving larger tree stumps to rot. This produces a zone of broken cover, an "untidy edge," often quite extensive, around their developing farms. Recent Ilocano immigrants clear *all* vegetation, including underbrush, as they expand their farms, creating a 'tiny edge." (See, for example, W. Peterson ms. in review). We would expect game to favor "untidy edges" for the broken cover they provide, and the wild fruits which are allowed to grow there.

All of these conditions, and the several variables attracting game, must be regarded as "ecotone expansion," and ecotone expansion is attractive to game. The forest-field ecotone is not a "line," but a transitional zone (Odum 1959: 278-281), a set of conditions. While stabilized crop fields continue to attract game, expansion itself is particularly attractive. Ecotone expansion however, can assume many forms. Reconstruction of clearing and crop damage histories in a single area does not permit control for these varying conditions of expansion. Experimentation or collection of comparative data on topographically different locales and different clearing practices are called for. Thus, speculation on the degree and mechanics of game attraction to varying conditions of ecotone expansion by farmers is a matter for further exploration. That game are attracted to areas of farming expansion seems fairly certain; we may, therefore, speculate on the implications of such attraction.

Edge effect, and especially the results on animal species of indigenous human disturbance in a tropical forested area, are recognized phenomena. We know little of the implications of these phenomena for ecology and conservation, however, and even less of their fine-grained mechanics. Dwyer (1978) explores the role of human disturbance in the distribution of rat populations in New Guinea and suggests its applicability to other species as well (p. 231). Drawing on work by Grassle and Sanders (Grassle 1973; Grassle and Sanders 1973) on marine life, he notes that disturbed areas "are likely to be occupied by opportunistic species." Opportunistic species characteristically produce large numbers of offspring. Certainly this observation appears applicable to pig populations in Palanan where litter size runs as high as 10. He explores, however, the role of continued disturbance over several millenia in the creation of patchy forests, connected at best by "tongues of increasingly disturbed forest," a condition he describes as an "archipelago" pattern of forest (pp. 229-230). He concludes that while initial disturbance may promote species diversity, continued disturbance inhibits such diversity (p. 231). Palanan, at this time, exhibits relatively limited disturbance, although logging in the Sierra Madre is rapidly taking a toll. Until now disturbance in Palanan has probably promoted species diversity, and population size of some food species.

Species diversity is important to the Agta lifeway as I have interpreted it. Palanan Agta exhibit dependence on a broad-range of economic modes and subsistence activities, and within this basic diversity they exploit diverse species (Peterson 1978a: 2, 25-26). Agricultural expansion, therefore, has very likely promoted continuation of the Agta lifeway. If we may retrodict from this intepretation, we could expect that prehistorically initial horticulture developed by some population in an area would support continued broad-spectrum hunting activity by other populations in the same area (cf. J. Peterson 1977b). It would create the environmental conditions supportive of species diversity and perhaps support larger numbers of some species because of the higher biomass

of food crops in cultivated fields. Where horticulture and hunting populations were not in competition, such distribution would also permit inter-ethnic exchange of food, thus further enhancing the hunting lifeway (J. Peterson, 1978b). These conditions are in keeping with Yellen's predictions (1977) for tropical hunters, and might partially account for the extraordinary temporal persistence of broad-spectrum technologies in Southeast Asia (cf. Gorma 1970; W. Peterson in press; Peterson and Peterson 1977; Kennedy 1977; Harris 1969; 1972). Certainly an examination of game attraction to an expanding ecotone requires reexamination of the assumption that farming induced an abrupt and deleterious effect on the environment upon which hunters depended.

Careful examination of such prehistoric implications requires a more complete understanding of contemporary disturbance effects and of relations between humans and their prey in Southeast Asia. Such an understanding is critical as well to planning for the future. The large "Imperata deserts" of much of northern Luzon stand as testimony to the need for environmental planning in developing nations. Palanan, which in Dwyer's (1978) terms, is a relatively young disturbance system demonstrates the potential for wild animal protein production which might be realized if appropriate planning is put to work (cf. Liem 1975; 1976; Liem and others 1976). In Palanan the cost of wild animal protein production is only about a 10 to 15 percent crop loss in stabilized areas.[9] Comparative data must be collected in topographically diverse areas within Palanan. Baseline data on game habits and population sizes are critical. Nonetheless, the existing data are provocative. Certainly, they warrant exploration of alternative interpretations of the roles of indigenous human populations in each other's environments, both now and prehistorically. They also suggest that with appropriate game-land management, developing nations might achieve compatible support for logging, farming, and a continued wild animal protein supply.

Notes

[1]These population estimates are based on census data collected from 1968-1970 (J. Peterson, 1978a).

[2]Liem et al. (1976) notes highly significant dependence on wild animal protein among indigenous populations in New Guinea, Ghana, and Botswana.

[3]These figures are, if anything, low. I collected these data by asking hunters what game they had recently sighted or killed, what game were sighted or killed by members of their hunting party, and by asking households what they had recently eaten, who killed it, and where. I also maintained records of kills I observed and sightings I made, and of game trapped by both Agta and farmers. In addition, I kept records based on informant recall and my observation of the membership of hunting and camping parties. These various sources were cross checked to avoid multiple reportings of the same kill. There may, however, be some hunters hunting in one of the three river valleys whom I did not interview, or some kill hunters failed to report.

[4]These observations of informants are borne out by my own records of game I sighted, and evidence of feeding sites. Records of kills indicate that Agta killed very significant numbers of game within a mile or less of the forest-field ecotone.

[5]While some camps are on portions of the dry river bed in the rainy season, any danger of flooding demands that others be on the lowest terrace of the river.

[6]Excavation of an old swidden floor by W. Peterson (personal communication) confirms the Agta recollection of the usual size of trees cut before the introduction of saws.

[7]In 1968-70, I calculated land holding at five to ten hectares per farmer. Land holdings fluctuate markedly over an individual lifetime, however. For a discussion of this see J. Peterson (1978a: 69).

[8]The wet rice grown in Palanan is dependent on rain for irrigation.

[9]I should point out that in terms of local exchange rates in 1968-70 a 10 percent crop loss is a cheap price to pay for the quantity of animal protein produced. Using my 1968-70 data on Palanan corn production and Agta pig and deer production for the northern area studied in 1978, I find that Agta pig and deer production is worth about five times as much as 10 percent of the corn crop. While this is an approximate statement of the relative value of fields crops and wild animal protein in the estimates of Palanan and Agta, it certainly indicates that some crop loss is worthwhile to support game.

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