CHAPTER 14

The Effect of Selective Logging on Baird's Tapir

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Many large ungulates of the tropical moist forest may become extinct before their biology is documented (Myers, 1984). Habitat destruction and overhunting are generally blamed for declining populations of wildlife (Fragoso, in press; Janzen, 1983*a;* Leopold, 1959; Terwilliger, 1978; Thornback and Jenkins, 1982; Williams and Petrides, 1980), but the precise influence of various human activities is poorly known (Johns, 1986, 1988; Myers, 1984). Logging is a common form of human disturbance that is often described as having a negative impact on tropical wildlife (Myers, 1984). However, surprisingly little is known about the effects of selective logging on large ungulates (Johns, 1986, 1988). To investigate such effects, the use of unlogged and logged forest patches by Baird's tapir (*Tapirus bairdii*) was examined in Belize, Central America.

Tapirs (Family Tapiridae) are restricted to the forests of Southeast Asia and Neotropical South and Central America (Thornback and Jenkins, 1982). All four extant species (*Tapirus bairdii, T. terrestris, T. pinchaque* and *T. indicus*) are considered endangered by the International Union For the Conservation of Nature and Natural Resources (Thornback and Jenkins, 1982). Baird's tapir has been extirpated in El Salvador and is extremely rare throughout its remaining range (Thornback and Jenkins, 1982). It is the largest terrestrial mammal inhabiting Neotropical forests (Fradrich and Thenius, 1972). This species is most common near water (Terwilliger, 1978), where it feeds on terrestrial and aquatic plants (Janzen, 1982; Terwilliger, 1978; Williams, 1984). At least one species, the Malay tapir (*T. indicus*), inhabits pristine forests and is considered a generalist herbivore (Williams and Petrides, 1980).

METHODS

The study site was located in the Macal River valley in the Chiqiubul Forest Reserve, Belize, Central America (Fig. 1). Topography consists of steep-sided low hills rising to an elevation of 370 m above sea level. Tapirs were censused in June, and the vegetation was sampled in July and August, 1985. The Chiqiubul Forest Reserve (1849 sq. km) lies in the subtropical moist life zone (Holdridge, 1967). From approximately January to May, the area experiences a dry season

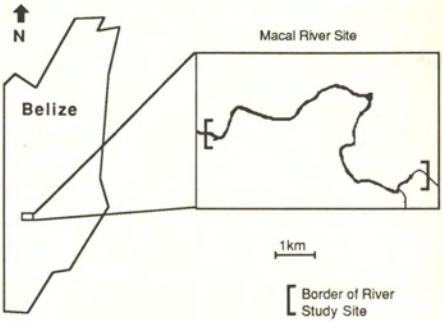

FIG. 1.—The Macal River study site, Belize, Central America.

(Hartshorn et al., 1984). The mean annual rainfall for the region is 1,476 mm per year (Hartshorn et al., 1984). Temperatures vary from a mean annual low of 19°C to a mean maximum of 29°C. The hottest months are from April to August.

The only human activity permitted in the reserve is selective logging (Hartshorn et al., 1984), which was initiated in the 1920s (Johnson and Chaffy, 1972). The study site included a 10–km length of river and an adjacent 60 ha of land extending 30 m to either side of the shoreline. This site was last selectively logged 16 years before this study (Carlos Requena, pers. comm.). The nearest permanent settlement or farm was located on the opposite side of a mountain range 26 km from the study site. This isolation ensured that tapirs were protected from squatters and hunters. The hunting of tapirs is illegal in Belize, and hunting of any animal is prohibited in the reserve.

Tapirs were located and censused by canoeing the 10-km length of river (transects) 14 times, eight times during the day and six at night. Normally two observers were in the canoe, but on one occasion four were along. A head lamp was used to locate tapirs at night. This proved effective because light reflects from their eyes even at a distance, and head lamp light does not unduly disturb the animals (Fragoso, 1983; Terwilliger, 1978). For each tapir sighting, the time, number of individuals, presence of young, sex (when possible), and location were recorded. Each sighting location was marked and later visited to collect vegetation data. Individual tapirs were identified by noting differences in size, skin spotting, sex, scars, and the presence of young. The starting, finishing, and total elapsed times, and rate of travel along each transect were recorded.

Preference ratio analysis (Crawley, 1983) was used to determine habitat preferences from data on the frequency of tapir encounters relative to the areal cover of habitat types. Habitat preference and use was also examined by determining the number of tapir-browsed plants in different habitats.

Because most plants could not be identified as to species, data were collected on 48 other vegetation variables (see Fragoso, 1987, for methodological details). These consisted of different plant growth forms, size classes, and structural characteristics. Tapirs select food plants according to species and physiognomy (Janzen, 1982; Terwilliger, 1978). They are known to eat herbs, cane (*Gynerium* spp.) shrubs, vines, saplings, ferns (Polypodiopsida), palms (Arecaceae) and grasses (Poaceae) other than cane (Fragoso, 1983; Janzen, 1982; Terwilliger, 1978). Cursory analysis of the data gathered in this study revealed that the latter three plant life forms were not eaten; consequently only the data on herbs, cane, shrubs, vines, and saplings were analyzed in detail.

Herbs were defined as nonwoody plant growth types usually less than 2 m in height. The shrub category included woody plants of low stature (< 4 m in height), typically with several stems arising from near the ground. Saplings were defined as woody plants with one main stem (< 3.2 cm in diameter at breast height, dbh). Vines were categorized as woody or nonwoody trailing or climbing plants. Cane was a tall, thick grass which grew to a height of approximately 3 m.

To survey the vegetation where tapirs were observed, a 5 by 5-m quadrat was centered at the observation site. If tapirs were in the water, the quadrat was located where the animal walked onto land. Because of flooding, only 19 areas where tapirs were sighted could be relocated for plant data collection.

For surveying the vegetation of the study area, six 500-m-long transect lines were randomly located within the study site, with three lines placed on each side of the river. Transect lines began 30 m inland from the shoreline; they paralleled but did not cross the river. Quadrats, 5 by 5 m, were located at 50-m intervals along the 500-m-long transect. In each quadrat, the following information was recorded: maximum canopy height and percent leaf cover, percent leaf cover at 50 cm above ground, diversity and density of various size classes of different plant life forms, and type and number of browsed and unbrowsed plants (see below for an explanation of how tapir browsing was determined).

TWINSPAN, a hierarchical clustering statistical method (Peter Quinby, pers. comm.) was used to classify the vegetation of 79 quadrats (60 from the transect lines and 19 from areas where tapirs were sighted) based on the similarity of the measured plant variables. The TWINSPAN analysis groups the most similar quadrats close to one another. TWINSPAN also lists the variables (e.g., plant growth types, structural characteristics) in rank order of their utility in segregating quadrats at each different level in the classification process. This information was used to draw representative diagrams of the habitats. Data from only 19 tapir-sighting quadrats could be used to examine habitat selection with statistical tests of significance.

To identify tapir–cropped plants, six wild tapirs were observed feeding during eight feeding periods (maximum observation time = one hour). After each feeding period, the feeding area was closely examined to evaluate the appearance of browsed plants (Fragoso, 1987). This procedure was necessary to distinguish between evidence of feeding by tapir and brocket deer (*Mazama americana*), another browser reported to occur in the study area (Leopold, 1959).

The confounding influence of brocket deer feeding was probably negligible, because of their smaller size (Eisenberg, 1981) and apparent low densities (Fragoso, 1987). Even where brocket deer occur and feed on the same plants as tapirs, there is probably minimal overlap between the parts cropped by the respective species because many plant parts within reach of tapirs are beyond that of brocket deer (Eisenberg, 1981).

RESULTS

The TWINSPAN analysis distinguished four habitats based on vegetation characteristics (Fig. 2). The understory of the unlogged closed-canopy forest habitat (unlogged forest) was dominated by palms (< 3.2 cm dbh). The tree (< 31.8 cm dbh) canopy attained a height of approximately 15 m. The 10–m–high canopy of the recently logged forest habitat was partially closed with many openings. Herbs dominated the understory, but shrubs were also common. The other recently logged habitat, the sapling forest, differed from the first two in having a lower canopy (height 4–8 m). Bottan palms (*Sabal* spp.) dominated the understory. Herbs and shrubs dominated the 2-m (occasionally 5–m)–high canopy of the floodplain habitat, which represents an early successional plant community. Patches of cane were mixed in with the other plant types.

When all plant variables were used in the TWINSPAN analysis, the four habitats paired by shared plant features, with the unlogged and logged habitats forming one pair and the sapling and floodplain habitats forming the other. In con-

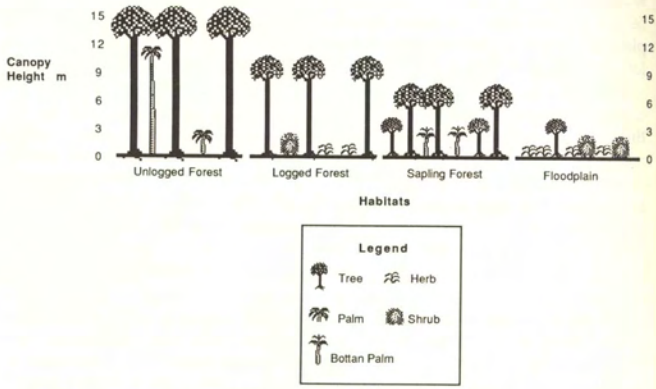

FIG. 2.—An illustration of the plant features that typify the logged, unlogged, sapling forest and floodplain habitats of the Macal River study site.

trast, when only herb and shrub density were considered, the unlogged forest is more similar to the floodplain and the unlogged and sapling forests resemble one another in having the lowest densities of herbs and shrubs (Table 1).

The river transects averaged 4 hours and 28 minutes per transect (speed = 2.2 km per hour). Tapirs were observed 22 times, and eight tapirs frequented this area (Table 2). Five areas where tapirs were sighted could not be relocated because of flooding; water removed the location markings. Tapir sightings were expected in logged forest, floodplain, unlogged forest, and sapling forest because these habitats covered extensive parts of the study site (63.5%, 15%, 10%, and 11.5%, respectively). However, tapirs preferred the floodplain habitat (Preference ratio (Pr) = 1.4) and the logged forest (Pr = 1.6). Tapirs were not seen in the recently logged sapling forests, or in the unlogged forest.

Sample sizes were insufficient to test statistically for significant preference comparisons among the four habitats. However, when the data from habitats with similar densities of herbs and shrubs are pooled, it can be demonstrated that tapirs prefer the logged habitat and floodplain over the unlogged and sapling habitats ($x^2 = 5.2$, $d.f. = 1$, $P < .025$). Theoretically, tapirs should have been seen in all habitats in proportion to availability if all were equally preferred.

Sixty-five percent of all cropped plants were located in the floodplain (Table 2). The logged forest contained 33% of the browsed plants, whereas only three

TABLE 1.—*The average density of tapir food plants per 5 by 5 m quadrat (n = 79) in the Macal Valley study site.*

Plant type	Unlogged forest	Logged forest	Sapling forest	Floodplain habitat
Herbs	4.4	16.7	2.9	66.4
Shrubs	10.0	23.6	6.1	15.2
Vines	23.9	16.9	59.6	24.5
Saplings	10.1	8.9	2.0	0.5
Cane	0.0	0.4	33.2	70.4
Total	48.6	66.6	103.7	177.4

TABLE 2.—*The number of tapir encounters and tapir cropped plants in four habitats of the Macal River Valley. Also listed is the number of vegetation sampling quadrats located in each habitat.*

Habitat	No. of quads	No. Tapir sightings	No. plants cropped
Unlogged forest	8	0	3
Sapling forest	9	0	0
Logged forest	50	15	82
Floodplain	12	4	158
Total	79	19	243

plants were eaten in the unlogged forest (1% of total). The distribution of cropped plants in each habitat departs significantly from the expected proportions ($x^2 = 141.2$, $d.f. = 3$, $P < .005$). More plants than expected were cropped in the floodplain, and fewer than expected were consumed in the logged, unlogged, and sapling habitats.

DISCUSSION

Tapirs prefer to feed in the earliest successional stage habitat of the floodplain, which supports the greatest density of all food plants, especially herbs. The logged forest, also dominated by early successional stage vegetation, had the second highest density of preferred tapir food plants. Not surprisingly, tapirs were observed in similar proportions in the floodplain plant communities and selectively logged forest. Both of these habitats were recently disturbed, one by flooding and the other by selective logging. No tapirs and only a few tapir-cropped plants were observed in the unlogged forest, and no tapirs were observed in the sapling forest. These latter two habitats had closed canopies and very low densities of food plants. The floodplain and logged forest habitats were probably selected over the other habitats because they contained the highest density of herbs. Tapirs feed preferentially on relatively young, fast-growing herbs (Fragoso, 1987).

Selective logging for a few species of trees, at a harvest intensity typical of the Chiqiubul forest (Johnson and Chaffy, 1972) should benefit tapirs because this activity mimics natural tree falls by creating gaps in the forest. These gaps, and clear soil areas, permit the growth of colonizing (fast-growing, short-lived) plants (Chivers, 1974; Crawley, 1983; Fragoso, 1987). The flush of colonizing plants and new foliage resulting from selective logging increases food availability for nonspecialized folivores (Chivers, 1974; Johns, 1986).

Tapirs occurred equally in the two habitats where they fed most, even though the floodplain contained a greater density of preferred food plants. One explanation for tapirs failing to congregate around their preferred food plants is that the logged forest may contain resources unavailable in the floodplain: greater protection from predators, fewer ectoparasites, or cover and shade from the sun. The last factor may be particularly important since large tropical mammals have difficulty dissipating excess body heat (Schmidt-Nielsen, 1978). The low canopy of the floodplain would increase the exposure of tapirs to direct sunlight and heat.

These results suggest that Baird's tapir actively seeks disturbed habitats such as those produced by logging. Tapirs probably prefer these sites because they have a higher density of herbaceous plants, which is their preferred food (Fragoso, 1987; Janzen, 1982). Tapirs eating the foliage of early successional plants may be selecting plants of higher nutritional value (Cates and Orians, 1975; Glander, 1978; C. M. Hladik, 1978; Hladik et. al., 1971; A. Hladik, 1978; Mattson, 1980; Waltz *in* Opler, 1978), and lower levels of toxic secondary compounds

than occur in plants of longer-lived communities (Cates and Orians, 1975; Freeland and Janzen, 1974; Glander, 1978; Janzen, 1978; 1983*b*).

Some folivorous primates respond favorably to selective logging (Johns, 1986; Oates, 1977; Struhsaker, 1972). However, some primate species are unaffected by selective logging, and other species seem to decline as a result of this activity (Johns, 1986). As nonspecialized folivores (Janzen, 1982; Terwilliger, 1978; Williams, 1984), tapirs seem to be following primates and other herbivores in selecting disturbed habitats with a high density of early successional plants.

It is not clear whether other species of tapirs also select disturbed habitat. Medway (1974) found that one Malay tapir browsed selectively on herbs, shrubs, and saplings colonizing an area disturbed by humans. In contrast, Williams and Petrides (1980) report that three Malay tapirs were denizens of undisturbed pristine forest; these individuals avoided early successional plant communities. Unfortunately, there is little information on the resource base of the Malay species.

By altering the distribution of early successional plant communities, selective logging may play an important role in tapir ecology. If tapirs maintain exclusive home ranges (Eisenberg and Thorington, 1973; Fragoso, 1987; Williams, 1979, 1984), selective logging could improve the home range quality of individuals dwelling in less preferred areas (possibly for one generation). Thus, a low quality home range becomes a preferred area, enhancing the biological fitness of the resident. When managing forests for tapirs, early successional plant communities should be included in the management strategy. If these are not available, selective tree removal can be used to increase the availability of food plants.

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SUMMARY

This study examined the impact of selective logging on tapirs (*Tapirus bairdii*) in Belize, Central America. TWINSPAN analysis was used to classify the vegetation of the study site based on 48 plant variables. Four habitats were distin-

guished, and tapirs were sighted 22 times. No tapirs were encountered in the unlogged forest habitat. However, they were observed with similar frequency in the selectively logged forest and in floodplain habitats. Tapirs prefer these two habitats over the unlogged and sapling habitats ($X^2 = 5.2$, $d.f. = 1$, $P < .025$). The distribution of tapir-cropped plants in each habitat departs significantly from the expected proportions ($X^2 = 141.2$, $d.f. = 3$, $P < 0.005$). Tapirs browsed more in the floodplain (n = 158 plants), although they also foraged in the logged forest (n = 82 plants). They cropped few plants in the unlogged forest (n = 3), and none in sapling forest habitats. Tapirs primarily browsed where their preferred food plants were at the highest densities (in the floodplain and logged forest). These habitats represented the earliest successional stages at the study site. The floodplain and logged forests were similar in that both had experienced major disturbances. These processes benefit tapirs in that they disrupt and eliminate mature vegetation and promote a growth flush of preferred food plants.

RESUMEN

Este estudio examina el impacto de la tala selectiva de árboles sobre tapires (*Tapirus bairdii*) de Belize en América Central. Se utilizaron análisis TWINSPAN para clasificar la vegetación del área de estudio basándose en 48 variables vegetales. Cuatro hábitats fueron distinguidos, y se observaron tapires en 22 ocaciones. No se encontraron tapires en los habitates forestales no talados. Sin embargo, se observaron con similar frecuencia en las zones de tala selectiva y en los hábitats be planicies de inundación. Los tapires prefieren estos hábitats sobre los hábitats no talados y de retoños ($X^2 = 5.2$, $g.l. = 1$, $P < 0.025$). La distribución de plantas forrajeadas por tapires en cada hábitat difiere significatívamente de las proporciones esperadas ($X^2 = 141.2$, $g.l. = 3$, $P < 0.005$). Los tapires pastorean más en las planicies de inundación (n = 158 plantas), aunque también se alimentan en los bosques talados (n = 82 plantas). Los tapires forrajearon muy pocas plantas en los bosques no talados (n = 3), y ninguna en los hábitats de bosque de retoños. Los tapires pastorearon mayormente donde su comida vegetal preferida se encontraba en las mayores densidades (en las planicies de inundación y bosques talados). Estos hábitats representan los primeros estados sucesionales en el área de estudio. Las planicies de inundación y los bosques talados fueron similares en cuanto que ambos han experimentado gran perturbación. Estos procesos benefician a los tapires en cuanto que perturban y eliminan vegetación madura y promueven rápido crecimento de las plantas preferidas en su alimentación.

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