A first assessment of damage to terrestrial ecosystems in Southern Belize
As caused by Hurricane Iris of October 8, 2001

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Introduction

In the evening hours of Monday October 8, 2001. Hurricane Iris hit the south of Belize. The hurricane made landfall near Independence in the Stann Creek district. At that stage Iris demonstrated sustained winds of over 140 mph. From Independence, Iris moved in a WSW course and left Belize less than two hours after landfall.

The resulting destruction was immense as was to be expected from a hurricane of this strength. What was immediately clear though, was the relatively narrow path of the hurricane. Iris was a “small” but extremely powerful hurricane. Unusual was also the very discrete path of destruction. In total approximately 775,000 acres (310,000 ha) appear to have been severely affected by the force of the hurricane.

Aerial assessment

On October 21, an aerial survey was carried out by means of a single engine plane. Locations were verified with help of the onboard GPS system. Approaching from the north the affected area was reached near Esperanza just south of Little Quartz Ridge in the Columbia River Forest Reserve. Little Quartz Ridge itself appeared virtually untouched. From here the edge of the path of destruction was followed over the Snake Creek Area and from there on over the Limestone plateau south of Bladen River. The path of destruction moved north a bit just at the mouth of the Bladen Nature Reserve and from there on followed the foothills of the Maya Mountains. Near Red Bank in the Stann Creek District, the path of destruction moved eastwards to the Placentia Peninsula. All of the coastline South of this point had suffered dramatically, but damage quickly became less obvious immediately south of Seven Hills just North of Punta Gorda. From here on the path of destruction followed a more or less westerly course until just south of Jalacte on the Belize/Guatemala border.

Damage to ecosystems

What was immediately obvious that the level of destruction within the affected area was dependent on the type of ecosystem. Most severely damaged were the lowland broadleaf forests, particularly near the coast. Hill forests were usually severely damaged on the windward side while seemingly unaffected on the leeward side. Savannas and pine forests appeared to be affected least of all, with most pine trees (*Pinus caribaea*) still standing and having a more or less intact crown. Other “tree” species with apparently a great resistance to the wind forces exerted here include the Palmetto (*Acoelorraphe wrightii*) and seemingly green and intact stands of this species stood out very clearly in savanna regions all along the coast. Another species with a great resistance appears to be the Royal Palm (*Roystonea regia*), although entirely leafless in the Monkey River area, most boles of these palms were still standing.

Damage was most dramatic in the broadleaf forests especially near the coast where wind forces were apparently highest. A list with damages according to ecosystem follows in table 1.

Table 1. Estimated damage per ecosystem

Ecosystem (following Meerman & Sabido 2001)	Damage estimate
Agriculture	Not assessed
Broadleaved lowland shrubland: *Miconia* variant	100%
Coastal fringe *Rhizophora* mangle dominated forest	100%
Deciduous broadleaf lowland riparian shrubland in hills	60%
Deciduous broadleaf lowland riparian shrubland of the plains	60 - 90%[1]
Deciduous lowland broadleaved disturbed shrubland	20%
Forest Plantations	20%
Littoral forests and beach communities	100%
Mixed mangrove scrub	100%
River	Fish kills
Riverine mangrove forest	100%
Short-grass savanna with needle leaf open forest	20%
Short-grass savanna with shrubs	20%
Swamp grassland without trees or shrubs	0%
Tropical evergreen broadleaf hill forest over calcareous soils in rolling terrain	60%
Tropical evergreen broadleaf hill forest over calcareous soils in steep terrain	75 - 100%[1]
Tropical evergreen broadleaf lowland forest over calcareous soils	75%
Tropical evergreen broadleaf lowland forest over calcium rich alluvium	75%
Tropical evergreen broadleaf lowland forest over poor or sandy soils	75%
Tropical evergreen broadleaf lowland forests over calcium-poor alluvium	100%
Tropical evergreen broadleaf lowland hill forest over calcareous soils: In steep terrain	60%
Tropical evergreen broadleaf lowland hill forest: *Calophyllum* variant	75%
Tropical evergreen broadleaf submontane forest over calcareous soils in rolling terrain	60%
Tropical evergreen broadleaf submontane forests over calcareous soils in steep terrain	60%
Tropical evergreen seasonal broadleaf hill forests over calcareous soils: In steep terrain	60%
Tropical evergreen seasonal broadleaf lowland forest over lime-rich alluvium	90%
Tropical evergreen seasonal broadleaf lowland forests over poor or sandy soils	75%
Tropical evergreen seasonal broadleaf lowland swamp forest: Aguacaliente variant	75%
Tropical evergreen seasonal needle-leaf lowland dense forest	20%
Tropical evergreen swamp forests: Permanently waterlogged	75%
Tropical evergreen swamp forests: Seasonally waterlogged	75%
Tropical lowland tall herbaceous swamp	20%
Urban	Not assessed
Water bodies	Fish kills

[1] Depending on location. Most damage near coast.

The level of damage is a intuitive measure only. No exact measurement could be taken during the overflight. An explanation for the levels of damage reported:

100 % - Total defoliation. Many trees down or limbed. The landscape looks virtually dead. Nevertheless, many trees still standing. See adjacent (top) picture of the Monkey River Area.

90 % - Most trees down or damaged, high level of defoliation but some "green" visible.

75 % - Many trees down or damaged. The landscape, especially what was the undergrowth still very green. See the lowland area near the entrance of Bladen Nature Reserve at the middle picture.

60 % - Damage very variable. Typically in steep hills. Windward side 70 – 100% destroyed but leeward side virtually intact. See the bottom picture taken at Seven Hills, North of Punta Gorda.

20 % - Few trees damaged. Typically in tree-poor landscapes such as savanna or herbaceous ecosystems. Pine trees (*Pinus caribaea*) appear to have weathered the storm better than any other tree species.

0 % - Very rare but the "Swamp grassland without trees or shrubs" in the Aqucaliente Wildlife Sanctuary was covered by a water column as normal during this time of year. No damage should have occurred there. Aquatic ecosystems although not apparently damaged may have suffered from low oxygen levels as a result of high inputs of organic matter. Massive fish die-offs have been reported.

Based on these observations a map has been prepared that presents a visual approximation of the levels of damage in the affected areas. This map is based on the Belize Ecosystems Map (Meerman & Sabido, 2001).

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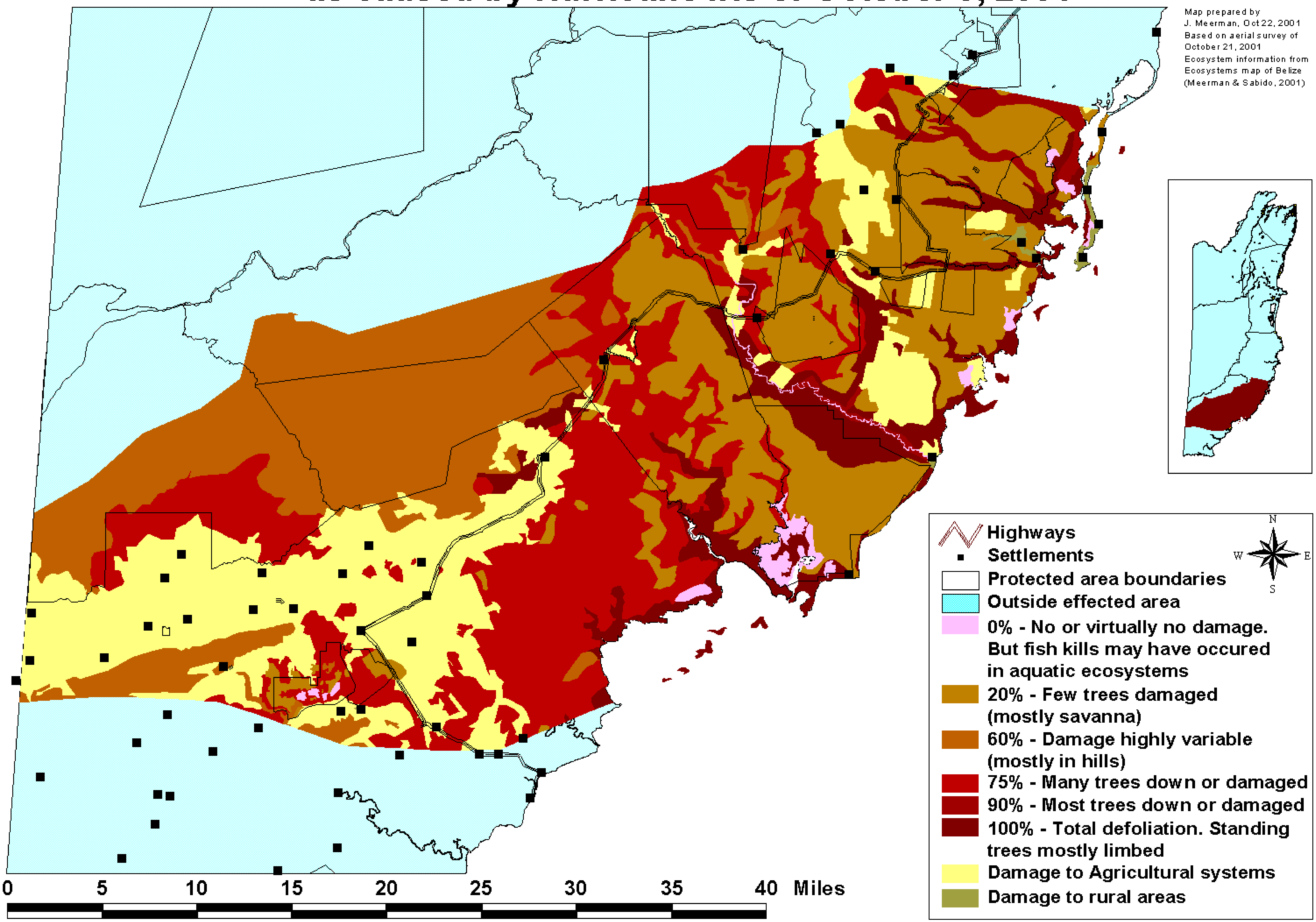

Recovery

Recovery of the individual ecosystems can be expected. Even from the ecosystems that have reportedly sustained 100 damage. In these areas, many of the still standing trees can still be expected to die as a result of infections following damage. But many trees will still recover as has been reported in other cases (see for example Biotropica 28(4A) of 1996 for related papers). Secondary growth species and vines will be the first to dominate the new forest. Over all species composition and species abundance will be affected for several decades at least.

The stylized model of post-disturbance tropical wet forest succession in figure 4 (Vandermeer et al, 1996) is illustrative:

a. The old growth forest prior to disturbance, with two species of canopy trees indicated by different shadings (in the real case there would be a multitude of species).

b. After the hurricane, the original canopy is effectively on the ground, enormous physical damage has been sustained, but the process of recruitment has already started with saplings and resprouts.

c. The end of the recruitment period is characterized by a low-lying, dense canopy, much lower than the original canopy. This is the stage at which intense competition begins, and the stage at which new population densities will either enhance or retard the long-term competitive process.

d. The mature forest which mayor may not contain the same mixture of species as the original forest. In this case, the two illustrated species exhibit a reversal in relative densities.

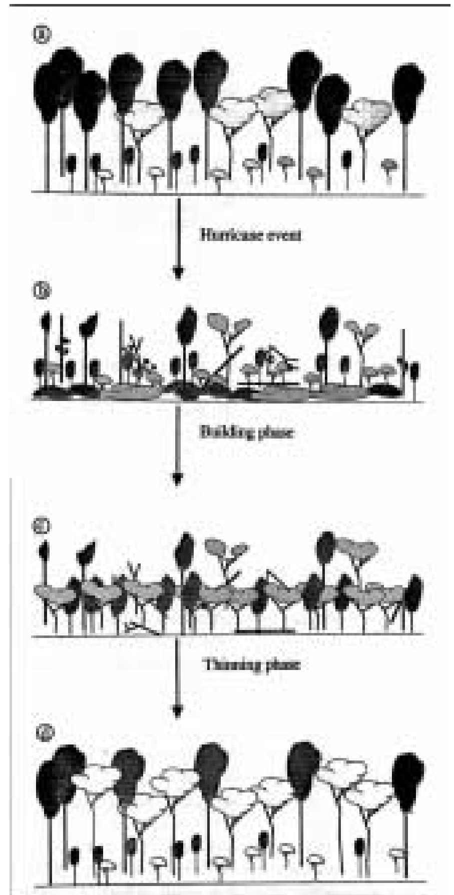

Figure 4. Stylized model of post-hurricane tropical forest succession (From Vandermeer et al. 1996)

According to various papers, phase c) can be reached in 5 – 7 years. Reaching phase d) probably takes 40 years or more. Even at that stage the effects of the regeneration will still be visible by the high density of secondary pioneer species and possibly lower species diversity.

Wildlife

One of the less visible effects of the hurricane is the effect on wildlife. Pre-hurricane wildlife densities and even distribution patterns are generally unknown so it will be difficult to assess changes.

Wildlife individuals that are not out right killed by the force of the hurricane will be faced with numerous challenges. This will particularly the case for arboreal species, mammals, birds, reptiles, amphibians as well as invertebrates. Shelter will be gone, food (especially for folivores and frugivores) gone, and in essence their entire ecosystem changed.

Some of these animals will try to migrate out of the affected area and there are numerous anecdotal records of animals wandering into villages. Such animals are prone to predation and starvation but should these animals survive their migration they may be faced with competing for territories with members of their own species. For species unable to migrate out, for example because there is no suitable habitat within migrating distance.

Throughout the affected area, there will be sufficient habitat left to provide wildlife with shelter and food. This is particularly the case in the Karst hills which usually have intact habitat on the leeward side of the hill. Survivors will have little problem migration to these habitats, and therefore the situation is of little direct concern.

However, the situation is very different for the animals in the broadleaf forests near the coast. Especially since most of these forests are more or less isolated by surrounding agriculture or savanna. Particularly the Howler Monkeys in the Monkey River are finding themselves in a very dire situation. It is very likely that most members of this very large and healthy population have been killed outright by the impact of the hurricane. However, there are reliable reports of more than 2 dozen survivors. Although seeming healthy, these individuals may still be threatened by exposure, predation and lack of food. This population is still at some risk of becoming locally extinct. Although, there will be sufficient foliage available in a very short time for the monkeys to feed on, they could still suffer from this food being unsuitable. The diet of Howler monkeys consists partly of fruit and this will not be available in their forest for several months to come.

This expected dearth in fruit will affect many fruit and seed feeding species such as Peccaries, Toucans, Parrots, Trogons etc. The change in forest composition and denser tangle of vegetation and dead trees may lead to a reduction in habitat for larger mammals such as White-tailed Deer, while smaller mammals such as Brocket Deer may benefit. Larger predators such as Puma and Jaguar may also be negatively affected because the regenerating forest may be too dense for them to move though. In essence, the affected ecosystems have undergone a very rapid and dramatic change and the present wildlife will have to adapt to this. Changes in wildlife composition will be as dramatic as the changes in structure and composition of the forest.

Aquatic ecosystems have been reported to have been affected by massive fish kills. This phenomenon can be explained by a rapid decrease in the oxygen levels in the rivers resulting from massive input of organic matter using up all the oxygen as it decomposes. Especially in fast flowing rivers and streams where fish and other aquatic organism are adapted to high oxygen levels, there will have been many species unable to cope with this situation.

Actions

The magnitude of the destruction makes meaningful action difficult. Many if not most ecosystems can be expected to recover without any interference.

- The biggest risk preventing ecosystem recovery is fire. With the massive amounts of dry timber on the forest floor, there is the potential for destructive forest fires. Plans should be prepared to prevent such events.
- Specific efforts to save wildlife may be necessary only in the Monkey River area and then particularly for the Howler Monkeys. It is suggested to monitor the surviving population closely for survival and health. If it is concluded that unsuitable food resources threaten the survival of the remaining monkeys, a rapid rescue effort and relocation (to for Example the Cockscomb Basin Wildlife Sanctuary) should be considered. Such a rescue plan should be prepared in advance.
- Most affected protected areas should still be considered viable, but management plans for these protected areas are to be revisited and adapted to the new situation.

Literature

Meerman, J. C. and W. Sabido. 2001. Central American Ecosystems Map: Belize. Programme for Belize. 2 volumes and Map.

Vandermeer, J., D. Boucher, I. Perfecto and I. Granzow de la Cerda, 1996. A theory of disturbance and species diversity: Evidence from Nicaragua after Hurricane Joan. Biotropica 28(4a): 600-613.