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**THE ROLE OF MANGROVE ECOSYSTEMS:
MANGROVE FOREST TYPES AND BIOMASS**

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12. Abstracts
Five physiognomic types of mangrove forests are identified on the basis of local geography, coastal position and relationship to terrestrial runoff and tidal flushing. Estimates of biomass, by compartment, are reported for an overwash forest, fringe forest, pine forest, a single-tree island and white mangroves (*Laguncularia racemosa*) on dredge-spoil banks. Forest biomass (dry weight, above ground) ranges from 25 kgm⁻². Standing stock detritus contributes up to 39 per cent of the total biomass and is related to storm damage.

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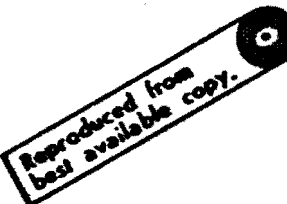
MANGROVE FOREST TYPES AND BIOMASS

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Mangrove Forest Types

The major producers in mangrove ecosystems are the three mangrove species, *Rhizophora mangle* (red), *Avicennia nitida* (black) and *Laguncularia racemosa* (white). Contrary to reports in the early literature, these species do not occur in successive landward zones in the south Florida area; such examples are the exceptions. Throughout the area the red mangrove tends to be the dominant species with black and white mangroves occurring in varying mixtures. Whereas there is no ubiquitous zonation pattern, there are apparent differences in the species composition and gross structure of the mangrove forests which appear to be strongly related to the periodicity of inundation by seasonal terrestrial runoff and tides. Five mangrove forest types are distinguishable based on these criteria and are briefly described:

Basin forests (figure 1)

These forest types are situated on the mainland in strand-like formations along the inland terrestrial drainages. As such, they are exposed to less saline water for longer periods of the year as compared to the more coastal types. Saline-water flushing probably occurs during extreme high tides and storm tides. These forests are particularly garbled in aspect

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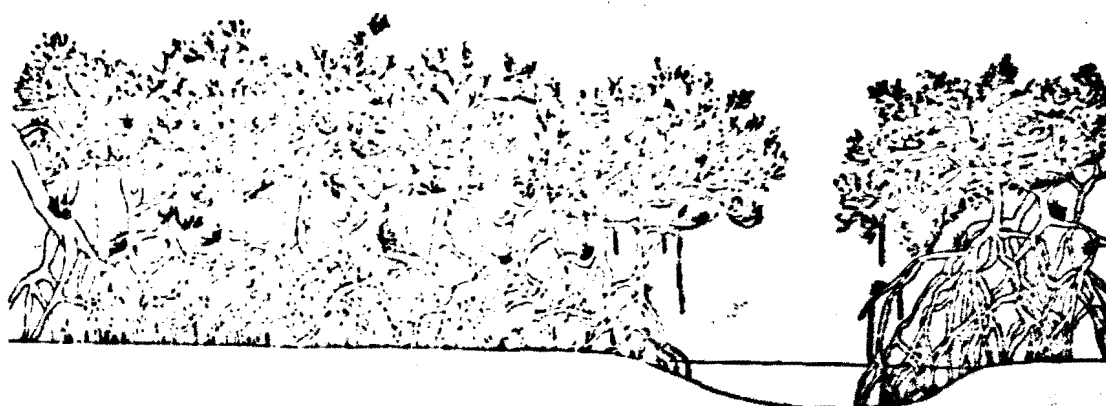


Figure 1.- Basin forest



Figure 2.- Riverine forest

and have a noticeable epiphytic flora dominated by vascular air plants. Inland from the drainages, other trees (e.g., red maple and bays) occur in association. Quantitative studies have not been made in this forest type and is reported here only to distinguish the five basic types.

Riverine forest (figure 2)

The riverine forests occur along the major river drainages emptying into the numerous bays inland from the Ten Thousand Islands. They are located on the "floodplains", frequently separated from the rivers by shallow berms. These rivers are flushed by the daily rise and fall of the tides. During the summer wet season, water levels rise and the salinity drops. Flow velocities in these riverine forests are very low; no scouring or redistribution of litter is apparent. Organic export occurs primarily in the form of labile materials, products of decomposition.

Fringe forests (figure 3)

Fringe forests are situated along the slightly sloping shorelines of the terrestrial mainland and the larger islands. For the most part, they are exposed to the open bays (e.g., Fahkahatchee and Fahka Union) and receive some wave action, albeit, slight. They are best defined on the larger islands whose elevations prevent daily overwashing by high tides. Tidal water movement is thus restricted to an in-out pattern which at any given point in the fringe is manifested as a rise and fall of the water level. Flow velocities are so small as to not flush large detrital debris into the bays on an outgoing tide. Organic export from the interior of the fringe forest occurs as small particulate and dissolved labile materials.

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Figure 3.- Fringe forest

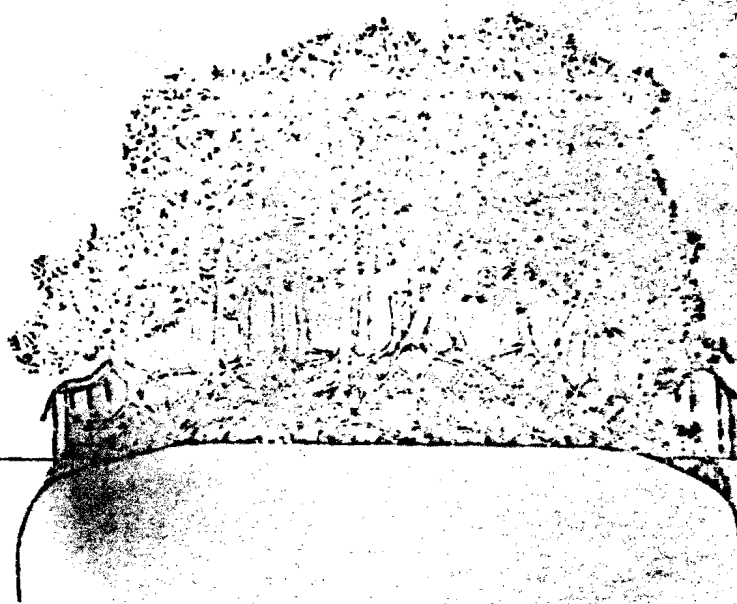


Figure 4.- Overwash forest



Figure 5.- Dwarf forest

Overwash forest (figure 4)

The overwash forest occur in and adjacent to the bays on small islands and finger-like projections of the larger land masses. In most instances they are situated almost perpendicular to tidal flow patterns and are overwashed with each high tide. The velocities are large enough to carry off all loose debris into the inner bays. As these materials are not redeposited by the retreating tides, there is an observable paucity of detritus in these forest.

Dwarf forests (figure 5)

This type is considered only to complete the tentative listing of south Florida mangrove forest types. The best examples occur in southeast Florida (Dade and mainland Monroe counties). These are forests of scattered, stunted mangrove individuals, occurring as dominants or in association with other plant forms. Based on leaf-scar analyses the small mangroves are not juveniles but rather are relatively old (ca. 50 years) mature specimens. Dwarfing or stunting is thought to be the result of extremely low nutrient inputs in both runoff and the tidal waters. Upland terrestrial drainage into these forest types is not readily discernible. Whereas they occur on low level terrain and are inundated by tides, the tide waters have marine characteristics including a relatively low dissolved nutrient load.

This classification based on topography and flooding characteristics is proving to be highly useful in developing input-output budgets of organic and inorganic material flows. Further studies on the specific hydro periods and salinity regimes may reveal the causes for the subtle

differences in species dominance. Furthermore, each type appears to behave uniquely in the way in which net production is partitioned between export as dissolved or particulate organic material. The processes of decomposition, recycling and export are described qualitatively in this report.

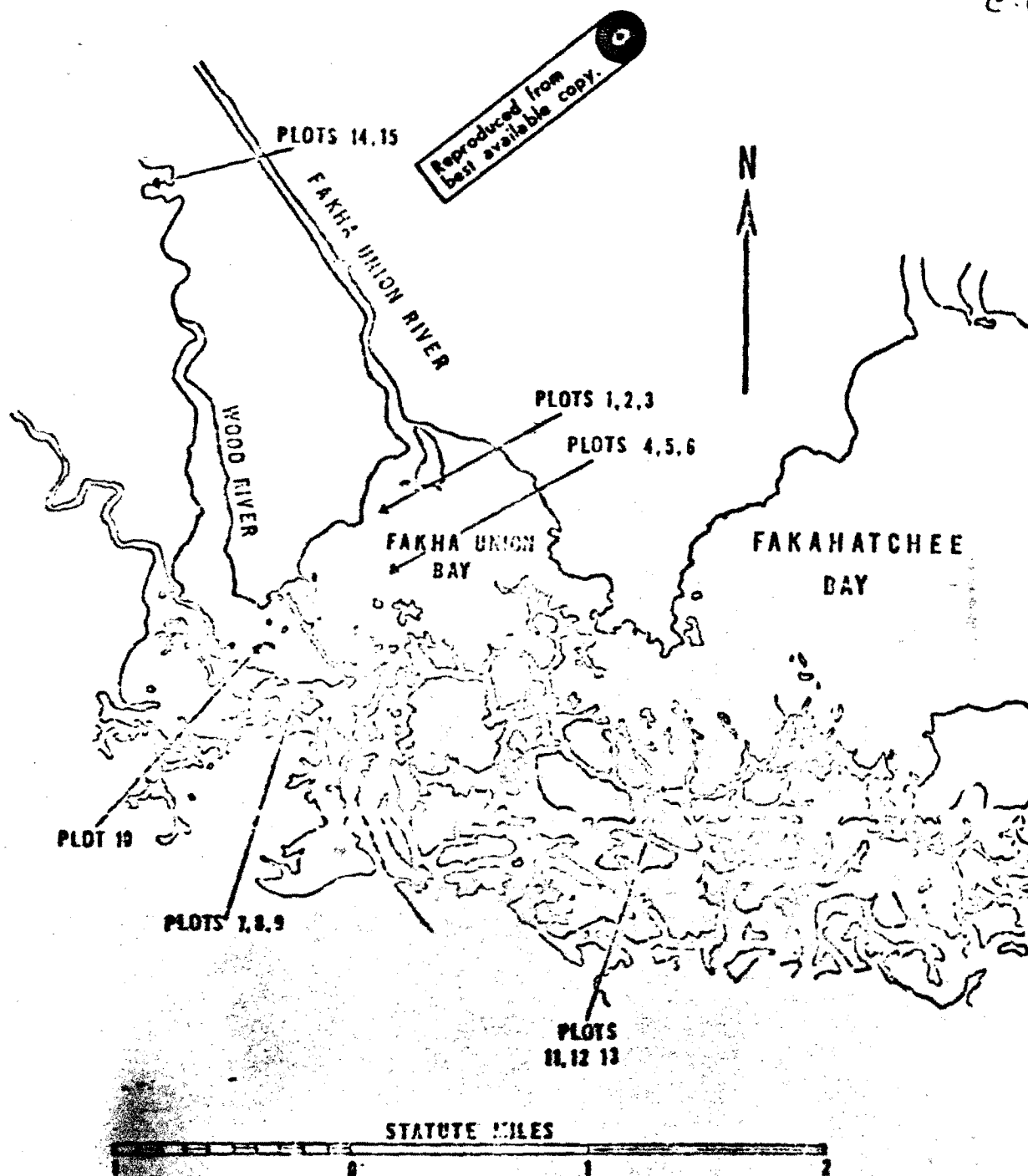
Mangrove Forest Biomass

The purpose of these studies on terrestrial biomass was to obtain compartment storage sizes for use in all future calculations and the computer simulations. Small areas of known size (locations in Figure 6) were sampled obtaining fresh field weights and subsamples for dry weight conversion and composition analyses. These data are summarized in Tables 1 to 6. Each number therein represents an average for up to 32 data points. The data are also summarized in Table 7 and compared with similar studies elsewhere. The data indicate that there is significantly more variation in mangrove forest biomass within a region than is indicated in the literature. This brings into question the validity of extrapolating data, such as is found in Heald (1971)¹, over large areas.

In addition to the topographic forest types, two types of apparent succession were studied; spoil islands and oyster bars. The spoil islands at the terminus of the Fahka Union river (Figure 6) are bordered by a relatively uniform (spacing and size, possibly age) stands of white mangroves. Two distinct variants are being studied, one on a hard sand-shell substrate (Site #1) and the second on a loose silt substrate (Site #2). The substrate differences show up in the root biomass (Tables 1 versus 2). Whether or not succession is occurring on the oyster bars is debatable at this time.

¹ Heald, Eric J. 1969. The production of organic detritus in a south Florida estuary. Ph.D. Diss. University of Miami. 110 p.

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INTENSIVE STUDY PLOTS IN THE TEN THOUSAND ISLANDS:

- Site 1 - Plots 1, 2, 3
- Site 2 - Plots 4, 5, 6
- Site 3 - Plots 7, 8, 9
- Site 4 - Plot 10
- Site 5 - Plots 11, 12, 13
- Site 6 - Plots 14, 15

Table 1. Standing stock biomass of a spoil island identified as Site #1. All data are expressed in g m^{-2} on an oven-dry (70° C) weight basis.

Compartment	Plot #1	Plot #2	Plot #3
Red mangrove leaves	0.0	0.0	3.0
" " wood	0.0	1.8	21.2
White mangrove leaves	62.2	279.0	150.
" " wood	131.0	505.0	177.0
<i>Batis maritima</i>	0.0	0.0	8.9
Grass	0.0	5.6	5.8
Railroad vine	0.0	4.7	0.9
Detritus	5.4	19.8	71.7
Roots	1275.	633.	614.
<u>Summary</u>			
Total leaves	62.2	289.3	168.6
" wood	131.	507.	198.
" roots	1275.	663.	614.
" detritus	5.4	19.8	71.7
Total aboveground biomass	199.	816.	438.
Per cent detritus	2.7%	2.4%	16.4%

Table 2. Standing stock biomass of a spoil island identified as Site #2. All data are expressed in g m^{-2} on an oven-dry (70°C) weight basis.

Compartment	Plot #4	Plot #5	Plot #6
Red mangrove leaves	0.4	6.3	0.9
" " wood	1.6	12.4	1.2
Black mangrove leaves	0.0	2.5	25.
" " wood	0.0	7.4	264.5
White mangrove leaves	156.	299.	319.
" " wood	364.	857.	1201.
Roots	560.	1727.	3602.
<u>Summary</u>			
Total leaves	156.4	307.8	344.9
" wood	366.	877.	1466.
" roots	560.	1727.	3602.
Total aboveground biomass	521.	1185.	1811.
Per cent detritus	0	0	0

Table 3. Standing stock biomass of a mangrove over-wash forest identified as Site #3. All data are expressed in g m^{-2} on an oven-dry (70°C) weight basis.

Compartment	Plot #7	Plot #8
Red mangrove leaves	391.8	693.9
" " fruit	2.0	23.6
" " wood	3127.	7048.
" " prop roots	5198.	4192.
White mangrove leaves	334.5	0.7
" " branches	1889.	0.0
" " wood	2022.	0.0
Detritus	1731.	1399.
<u>Summary</u>		
Total leaves	726.3	694.6
" fruit	2.0	23.6
" wood	7038.	7048.
" prop roots	5198.	4192.
" detritus	1731.	1399.
Total aboveground biomass	14695.	13357.
Per cent detritus	11.8%	10.5%

Table 4. Standing stock biomass of an isolated red mangrove tree, 3.5 m tall and a crown circumference of 3 m, from Site #4. All data are expressed in g m^{-2} on an oven-dry (70°C) weight basis.

Compartment	Plot #10	
	Total	per crown area
Red mangrove leaves (green)	3365.	480.
" " " (yellow)	134.	19.
" " fruit	54.8	7.8
" " wood	12680.	1809.
free prop-roots	8168.	1165.
rooted prop roots	9929.	1416.
subsurface root (ash-free oven-dry weight)	5615.	801.

Table 5. Standing stock biomass of mangrove fringe forest identified as Site #5. All data are expressed in g m^{-2} on an oven-dry (70°C) weight basis.

Compartment	Plot #11	Plot #12	Plot #13
Red mangrove leaves	572.7	487.0	579.9
" " fruit	2.8	21.0	13.1
" " branches	1475.	1601.	1855.
" " wood	3413.	4714.	4646.
" " prop roots	2227.	2720.	1719.
Black mangrove leaves	4.8	.4	0.0
" " branches	22.5	1.1	0.0
White mangrove leaves	15.9	96.9	150.8
" " branches	-	310.	-
" " wood	68.3	1801.	6530.
Detritus	2273.	6025.	9841.

Summary

Total leaves	593.4	584.3	730.7
" fruit	2.8	21.0	13.1
" branches	1700.	1912.	1855.
" wood	4096.	6515.	10996.
" prop roots	2227.	2720.	1719.
" detritus	2273.	6025.	9841.
Total aboveground biomass	10992.	17777.	25145.
Per cent detritus	20.9%	33.9%	39.1%

Table 6. Standing stock biomass of a riverine mangrove forest identified as Site #6. All data are expressed in g m^{-2} on an oven-dry (70°C) weight basis.

Compartment	Plot #14	Plot #15
Red mangrove leaves	367.2	168.9
" " fruit	14.8	0.04
" " branches	1633.	524.
" " wood	5977.	867.
" " prop roots	1464.	306.
Black mangrove leaves	13.6	780.
" " branches	44.0	2243.
" " wood	308.0	12499.
White mangrove leaves	0.2	1.9
" " branches	0.0	0.3
Detritus	4295.	3393.
<u>Summary</u>		
Total leaves	381.	951.
" fruit	14.8	.04
" branches	1677.	2767.
" wood	6285.	13366.
" prop roots	1464.	306.
" detritus	4295.	3393.
Total aboveground biomass	14117.	20783.
Per cent detritus	30.4%	16.3%