SARASOTA COUNTY

ESTUARINE SHORELINE INVENTORY

FINAL REPORT

Submitted to:

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MOTE TECHNICAL REPORT 120

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INTRODUCTION

Like all coastal communities throughout Florida, Sarasota County is experiencing tremendous growth which stresses its natural resources. Estuarine shorelines are transitional areas between upland development and the economic, recreational and biological resources of each bay and estuary. These bay resources are a vital link to the natural and cultural health of the community.

In addition to providing a transitional area and buffer between upland areas and the estuary, the shoreline is the location of vital wetland habitats. Figure 1 shows cross-sections of typical shoreline habitats for Sarasota County. The value of tidal wetlands is well-documented and services performed by tidal wetlands are summarized by Estevez and Mosura (1982) as follows:

1. Production of organic matter for consumption by detritivores (filter feeders and bottom feeders) which are in turn fed upon by other animals, including valuable fish species;

2. Refuge, habitat and/or nursery area for sport and commercial fishes and invertebrates, whether or not foodstuffs (item 1) are also important;

3. Refuge, habitat and feeding area for several rare, threatened or endangered species;

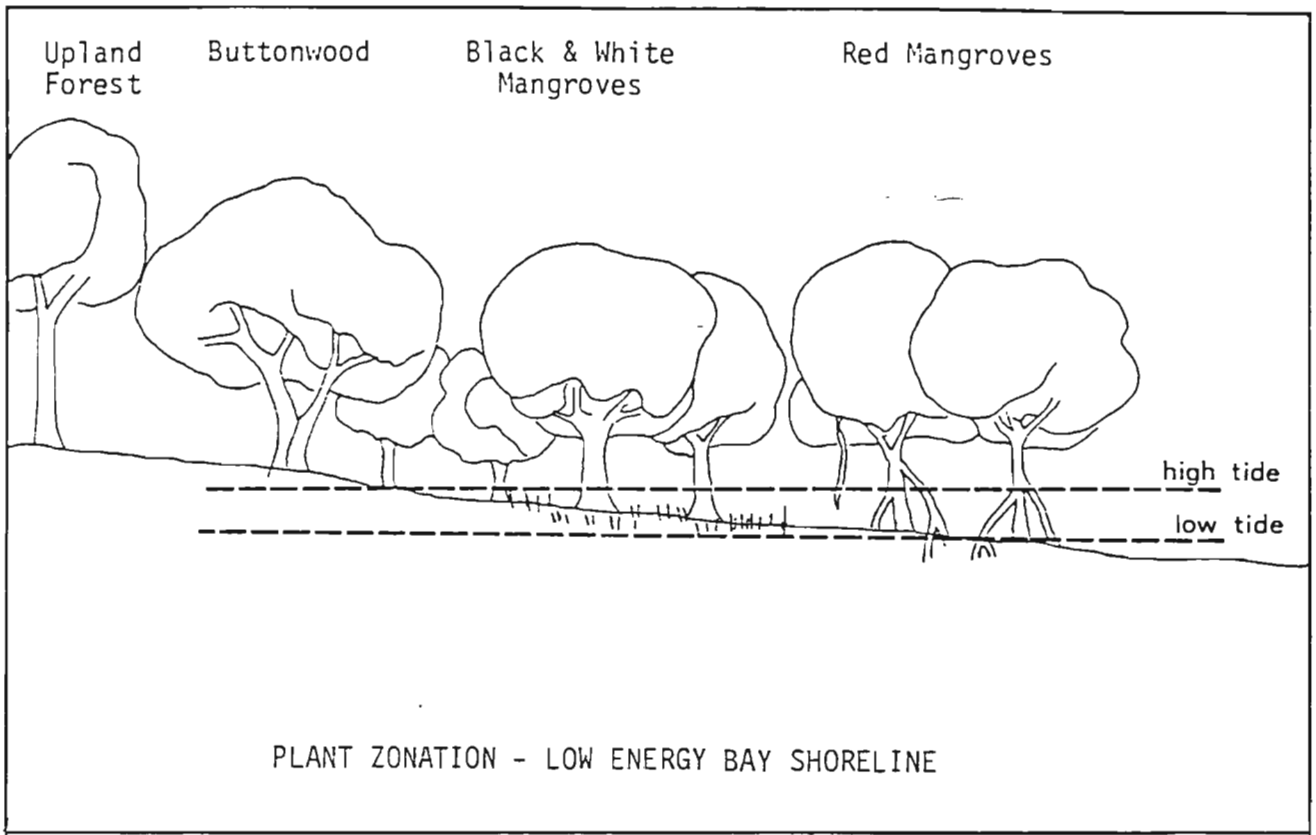
4. Production of fuel (wood) and food (honey) for humans;

5. Acceleration of shoreline accretion by stabilizing sediments and retarding erosion;

6. Buffering valuable coastal residential, commercial and/or agricultural areas from storm damage by retarding surges;

7. Buffering suburban and rural areas from urban congestion by providing visual, acoustic, and air pollution buffer;

8. Retaining flood waters, both tidal and fresh, and assimilating nutrients from runoff. Toxic materials can be "scrubbed" from runoff by wetlands.



PLANT ZONATION - LOW ENERGY BAY SHORELINE

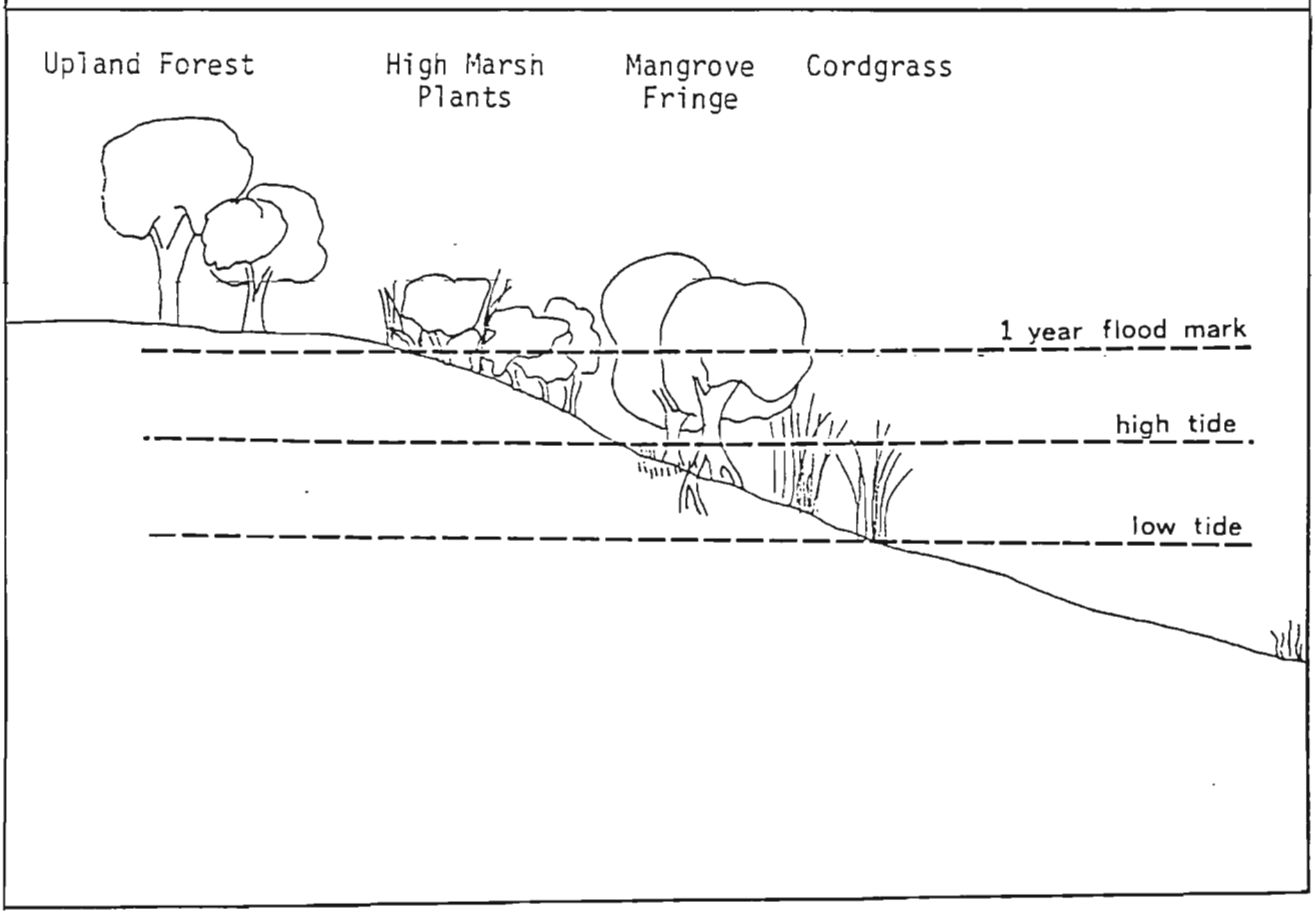


Figure 1. Cross-sections of shoreline habitats for Sarasota County (from Evans et al, 1978).

9. Mangrove and salt marsh are popular landscaping elements because they are salt and flooding tolerant and grow where conventional landscaping plants cannot.

10. Scientific and educational value.

The purpose of this study is to document the alteration that has occurred to estuarine shorelines throughout Sarasota County, determine long-term trends, evaluate the success of current management practices, and recommend policies and strategies for managing the shorelines as coastal resources in the future. Figure 2 shows the location of the study area.

Two previous studies (Evans, Brungardt, and Evans, 1978; Kimball and Fortune, 1987) documented shoreline changes in Sarasota County. Evans et al (1978) mapped and classified the shoreline types for all bay shorelines, including the passes and tidal creeks to the first bridge, for 1948 and 1978. Kimball and Fortune (1987) conducted a similar study for Sarasota Bay in 1987 using a different classification scheme. Sarasota County personnel, under the direction of Belinda Perry, updated the field data for the Evans et al study during 1986 and 1987, exclusive of Sarasota Bay.

The objectives of this study were to: 1. Collectively analyze the data gathered by Sarasota County personnel, the Kimball and Fortune (1987) study and the earlier Evans et al study (1978), 2. map the information according to the Evans et al classification scheme, and 3. quantify the long-term trends in shoreline change. Laws and ordinances regulating shoreline development are also evaluated and assessed for effectiveness, particularly during the last ten years when most regulations have been in place.

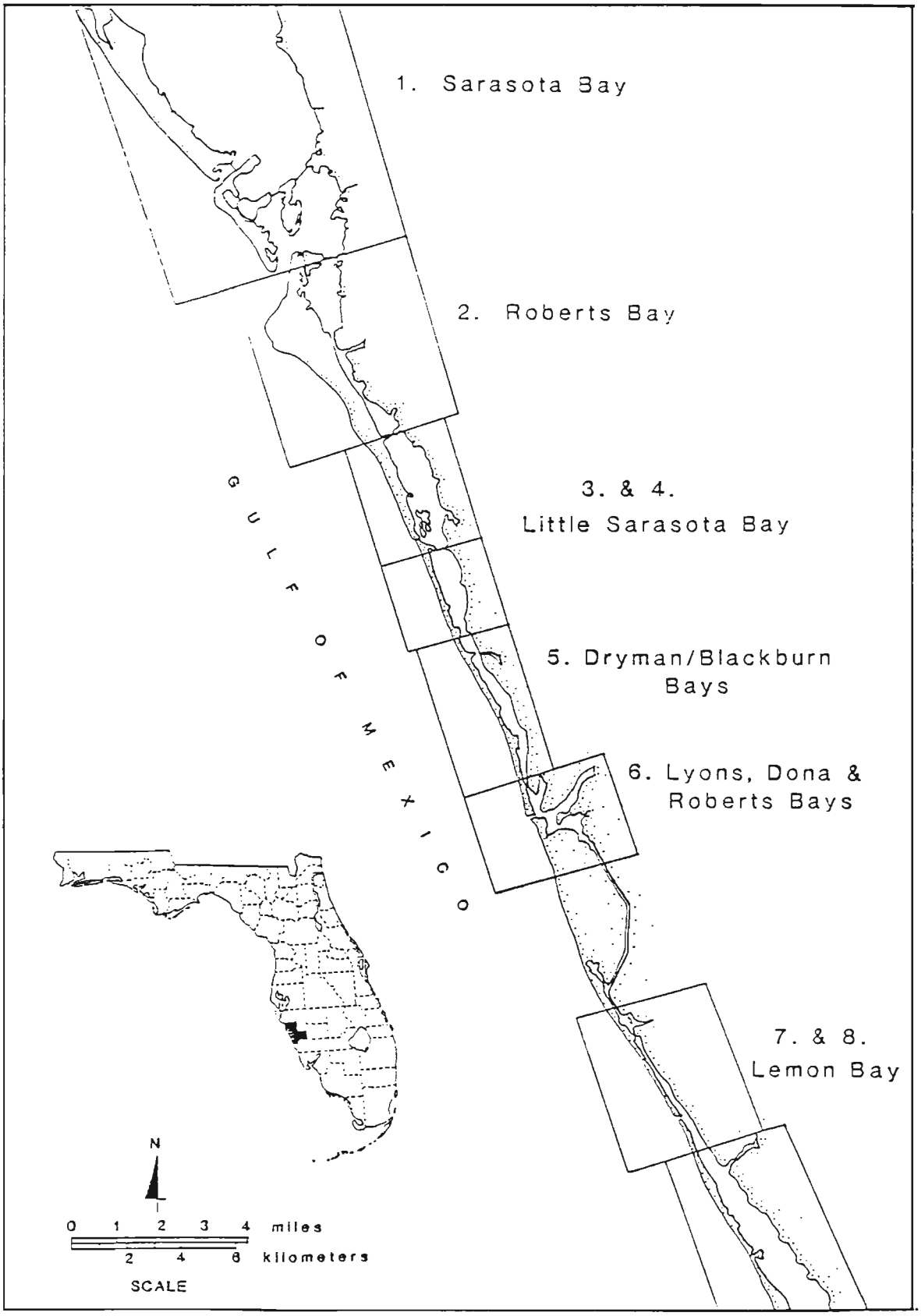


Figure 2. Location map showing the distribution of the shoreline maps and bay system boundaries.

MATERIALS AND METHODS

Field data for 1986 and 1987 were mapped according to the classification scheme presented in Table 1. These field data were collected by the Sarasota County Department of Natural Resources (under the supervision of Belinda Perry) and by Amy Kimball and Bruce Fortune as presented in their 1987 study. These data were 100% field checked by the respective parties and spot-checked for accuracy during this study. Discrepancies in the Kimball and Fortune study were identified in two locations for the Sarasota Bay section. The location of a seawall on City Island was extended on the map beyond the known boundaries and a thin strip of mangroves along the perimeter canal of Bay Isles (Longboat Key) was misidentified as Australian pine. Once these errors were verified, the maps were changed accordingly and all measurements correspond to these changes.

Maps similar to those prepared in the Evans et al (1978) study were prepared except that the new maps provide some overlap and are prepared by bay system (Sarasota Bay, Roberts Bay, Little Sarasota Bay, Lemon Bay and combined Dryman-Blackburn-Lyons Bays and Dona/Roberts Bay). Original mylar maps are provided at a 1"=660' scale. Data were entered and analyzed using LOTUS 123 spreadsheet software.

Because of certain minor changes in data gathered in 1986-87 and the way data were presented in Evans et al (1978), the original 1948 and 1978 maps were re-measured in order to accurately compare the data to current information. Linear measurements for all maps for 1948, 1978 and 1987 were made using an Alvin Inch Counter. Multiple measurements of discrete areas

Table 1. Classification scheme for inventorying shoreline types (after Evans et al, 1978). (Note: In some cases, field maps for 1987 subdivided some of the classifications by plant species.)

Shoreline Type	Description
BEACH	Bay and estuarine shorelines characterized by a low, gentle slope and composed of shell, fine sand, or silty sand that is exposed at mean high tide.
BULKHEADS	Man-made structures forming a solid vertical wall along the shoreline.
REVETMENT	Hardened shoreline composed of rock-rubble or large stones stacked together, but not cemented together.
MANGROVES	Shorelines where one or more of the following plant species dominate: Rhizophora mangle (red mangrove), Avicennia germinans (black mangrove), Laguncularia racemosa (white mangrove), and Conocarpus erecta (buttonwood).
AUSTRALIAN PINE/ BRAZILIAN PEPPER	Shorelines dominated by exotic plant species, primarily Casuarina equisitifolia (Australian pine) and/or Schinus terebinthifolius (Brazilian pepper).
OTHER VEGETATION	Shorelines dominated by plant species not included in the MANGROVE or AUSTRALIAN PINE/BRAZILIAN PEPPER clasifications.

or whole bay systems were randomly conducted to determine measurement error. In all cases, multiple measurements were within 1%. Measurements were made for entire shoreline length and for primary and secondary shorelines for each shoreline type. Primary shore types were based on the most seaward position and all landward types were considered secondary. The measurements are presented by bay system, mainland vs. barrier island, and for the entire county (with all intra-bay islands included in the barrier measurement).

Figure 2 presents an index map for the estuarine shorelines showing the distribution of the shoreline maps and the boundaries of the various bay systems for measurement purposes. Bay system boundaries were established at bridges, if possible (i.e. Sarasota/Roberts Bays at Siesta Drive bridge and Roberts/Little Sarasota Bay at Stickney Point Bridge, etc.). The portion of Siesta Key north of the Siesta bridge is included in the Roberts Bay measurement.

The "Other Vegetation" category represents native vegetation other than mangroves. Field data for 1987 identifies Spartina spp. and Juncus roemerianus separately from other native vegetation. While these are identified individually on the maps, data are combined to enable comparison to earlier data. Similarly, the 1987 Australian Pine/Brazilian Pepper (AP/BP) category was mapped individually as Australian Pine or Brazilian Pepper where appropriate but combined for analysis.

Shoreline areas that were not included in the 1987 revisions were also excluded from 1948 and 1978 measurements. The only significant areas excluded from this inventory are the Grand Canal System on Siesta Key west of the Highway 758 bridge, the Venice Bypass canal, and the estuarine

portion of the Myakka River.

RESULTS

All results are presented in a spreadsheet as linear measurements and percent (Appendix 1) and summarized by miles in Tables 2 and 3. Percentages are based on the measured primary shoreline length as follows:

Primary Shoreline Length = Primary Beach + Primary Bulkhead + Primary Revetment + Primary mangrove + Primary Other Vegetation + Primary Exotics.

Because of overlap between primary and secondary classifications, the sum of shore type totals (i.e. total bulkhead, total mangrove, etc.) is more than 100% and because many shores had 2 or 3 categories the percent sum of all secondary types plus primary types is greater than the percent sum of total types. It is necessary to compare total and secondary shore types to shoreline length (for calculation of percentages) in order to make secondary types comparable and relative to primary types and overall shoreline lengths. Otherwise, secondary and total shorelines would only be comparable to themselves and of little value in assessing their distribution relative to bay wide or county wide inventories.

Figure 3 presents the total shoreline length for the individual bay systems and the County total for 1948, 1978, and 1986-87. This figure (as well as other summary charts) separates bay and county analyses into barrier, mainland and total categories. All bay systems showed significant increases in shoreline length from 1948 to 1978 with an overall increase of more than 60 miles (43%). These changes were divided almost equally between

Table 2. Shoreline changes (in miles) 1948, 1978, and 1986-87.

		BEACH		BULKHEAD		REVETMENT		MANGROVE		OTHER VEGETATION		AUST. BRAZ.	PINE/ PEPPER	TOTAL
		PRIM.	SEC.	PRIM.	SEC.	PRIM.	SEC.	PRIM.	SEC.	PRIM.	SEC.	PRIM.	SEC.	MILES
Sarasota Bay	1948	16.28	0.00	7.43	0.00	n/a	n/a	12.17	1.05	0.41	14.93	0.61	3.08	36.90
	1978	13.25	0.00	32.56	2.12	3.20	0.89	16.07	0.49	0.91	9.85	1.09	3.64	67.09
	1987	8.23	0.00	32.83	2.58	6.75	1.25	15.45	6.95	0.53	3.01	0.79	8.40	64.56
Roberts Bay	1948	5.14	0.00	1.85	0.00	n/a	n/a	20.43	0.71	1.18	3.40	0.09	0.36	28.69
	1978	4.05	0.00	14.68	0.76	1.61	0.83	17.96	3.70	1.99	2.35	0.33	4.51	40.61
	1987	3.83	0.00	16.00	0.55	2.40	0.91	18.12	5.00	0.70	2.14	0.33	4.40	41.38
Little Sarasota Bay	1948	9.89	0.25	0.19	0.00	n/a	n/a	13.98	2.45	1.76	7.26	0.00	0.11	25.83
	1978	5.70	0.08	10.06	1.09	1.55	0.14	11.58	2.99	0.80	2.19	0.24	4.45	29.94
	1987	4.36	0.00	10.36	0.53	1.36	0.39	13.37	2.09	0.23	1.90	0.26	4.15	29.95
DBIDR* Bays	1948	2.16	0.00	2.40	0.00	n/a	n/a	23.33	0.39	2.86	7.19	0.55	0.35	31.31
	1978	3.85	0.00	10.34	0.59	9.46	0.41	14.17	3.04	1.13	6.18	0.24	3.86	39.19
	1987	2.13	0.00	10.49	0.94	13.33	1.28	16.22	3.30	0.83	3.24	0.13	5.28	43.11
Lemon Bay	1948	5.04	0.00	0.06	0.00	n/a	n/a	17.30	2.74	1.43	2.08	0.00	0.00	23.83
	1978	8.25	0.00	6.31	0.05	1.86	0.26	14.22	5.41	2.16	14.24	0.08	0.91	32.89
	1987	6.30	0.00	6.55	0.16	2.40	0.29	14.46	5.40	1.94	11.98	0.04	2.29	31.69
TOTAL	1948	38.50	0.25	11.93	0.00	n/a	n/a	87.23	7.34	7.64	34.85	1.25	3.90	146.55
	1978	33.79	0.08	73.95	4.61	17.69	2.53	73.53	15.63	6.99	34.80	1.96	17.38	207.91
	1987	24.76	0.00	76.23	4.75	26.24	4.11	77.63	22.74	4.21	22.26	1.54	24.61	210.61

* Dryman, Blackburn, Lyons, Dona and Roberts Bays

Table 3. Summary data on shoreline changes for Lyons and Dona/Roberts Bays.

		1948 feet	percent	1978 feet	percent	1987 feet	percent
Beach	primary	3,960	7	3,630	5	3,234	4
	secondary	0	0	0	0	528	1
Bulkhead	primary	9,372	16	37,290	47	35,376	45
	secondary	0	0	2,112	3	4,026	5
Revetment	primary	0	0	15,180	19	13,596	17
	secondary	0	0	132	0	4,224	5
Mangrove	primary	34,782	59	21,054	26	25,608	32
	secondary	0	0	858	1	3,432	4
Other Vegetation	primary	8,052	14	1,716	2	1,188	2
	secondary	11,088	19	3,234	4	2,376	3
AP/BP	primary	2,508	4	1,254	2	66	0
	secondary	1,716	3	7,458	9	10,362	13
TOTAL SHORELINE LENGTH		58,674		80,124		79,068	

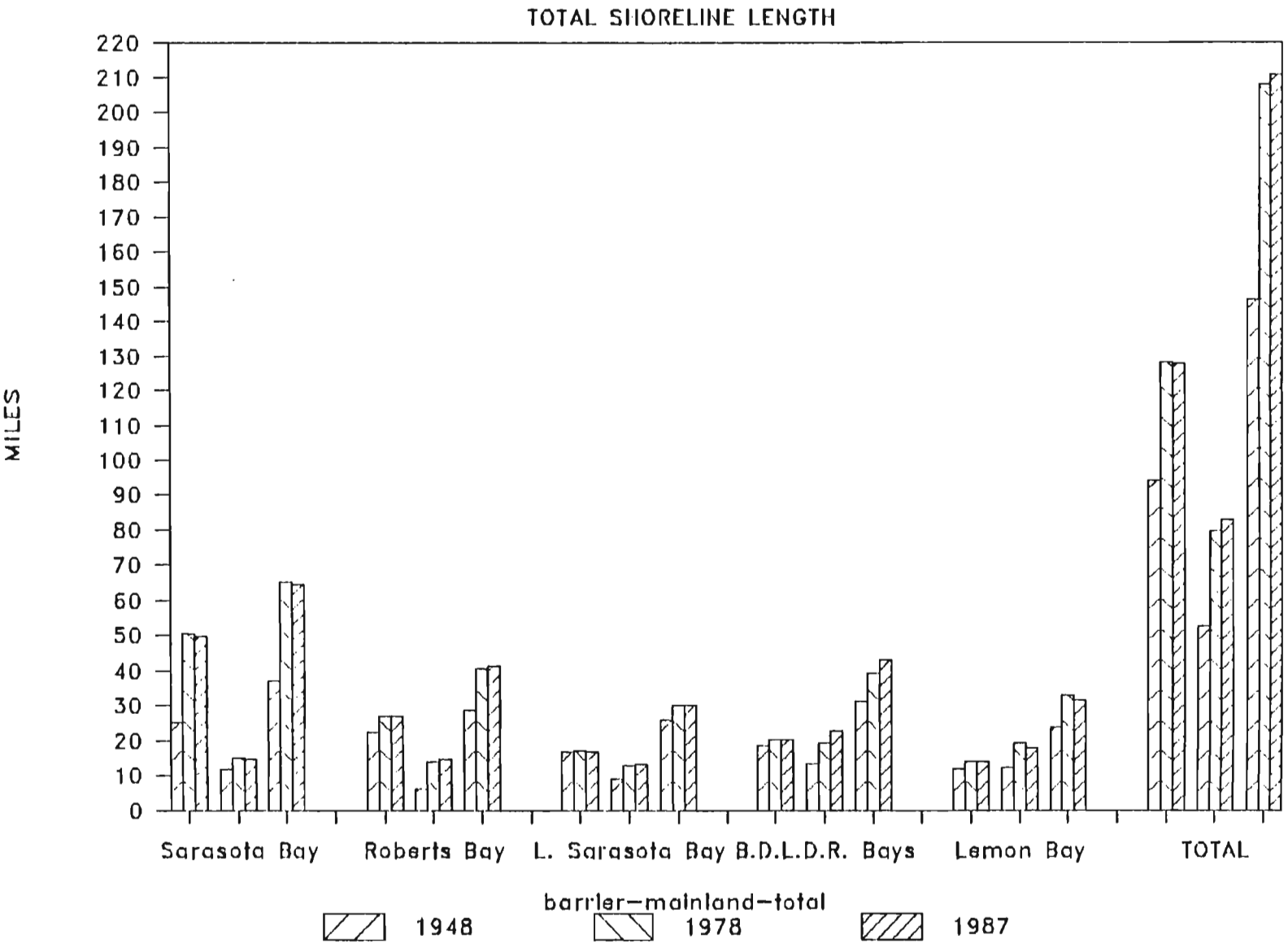


Figure 3. Total shoreline length by bay system and County for 1948, 1978 and 1986-87.

barrier and mainland shorelines. From 1978 to 1987 there has been a net increase of 2.7 miles (1%). Slight decreases occurred in Sarasota and Lemon Bays.

The distribution of primary beach shorelines is presented in Figure 4. This shore type accounted for 26% of all county shorelines in 1948 and has declined to 12% in the 1987 inventory (13% on barrier island and 11% occurring on the mainland). The 1948 inventory shows that Sarasota, Little Sarasota and mainland Lemon Bay had 44%, 38% and 34% primary beach, respectively. These values account for more than 75% of all primary beach and 20% of all 1948 shorelines, indicating higher energy shorelines relative to other, mangrove dominated 1948 shorelines throughout the county. Secondary beach (shore type) is negligible throughout the entire county for all analyses almost by definition and will not be considered further. The decline in primary beach is significant particularly in light of the high 1948 proportion of primary beach. However, some discrepancies may be due to sampling differences between the 1978 and the current study. Data were collected based on estimated mean high tide although field estimates may vary between field personnel due to different interpretations or observations of high and low tides.

Primary bulkhead data are presented in Figure 5 with bulkhead/revetment data combined for 1948. As expected, stabilized shorelines represent a small proportion in 1948 (generally less than 10%) with the exception of mainland Sarasota Bay which was 54% bulkheaded in 1948. Shorelines were extensively bulkheaded (and created) between 1948 and 1978. County-wide percentages show 35% of all shorelines bulkheaded by 1978 with a progressive decrease from north to south county areas.

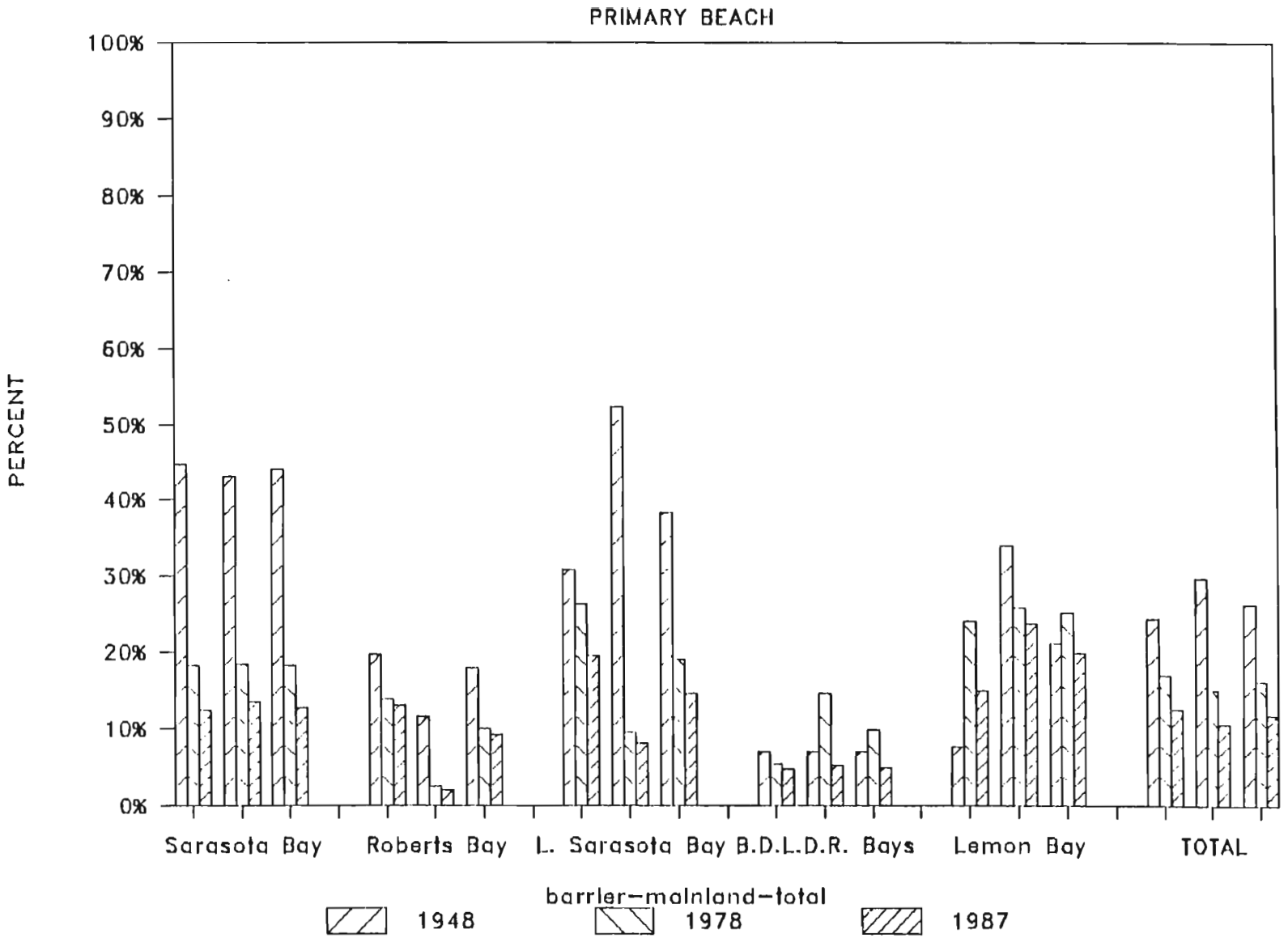


Figure 4. Distribution of primary beach shorelines 1948, 1978, and 1986-87.

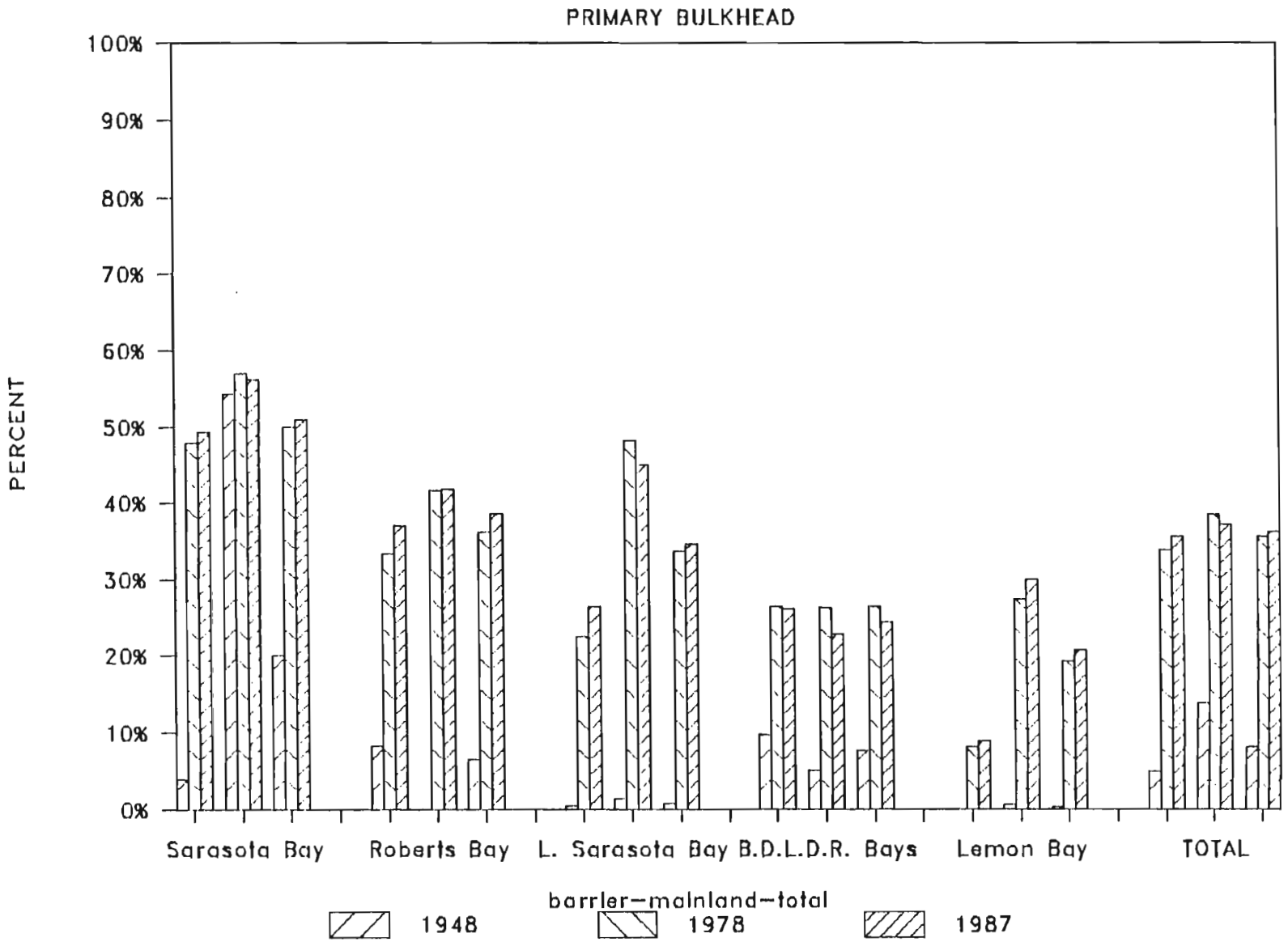


Figure 5. Distribution of primary bulkheads 1948, 1978 and 1986-87.

From 1978 to 1987, the rate of bulkheading increased by 1% (net) and included several areas of decreased shoreline hardening. Areas of decreased shoreline hardening were mainland Sarasota Bay, mainland Little Sarasota Bay and both barrier and mainland portions of Blackburn/Dryman/ Lyons/ Dona-Roberts Bays. These decreases in primary bulkheads represent only 1200-1700 feet. The percentage decrease in the Blackburn/Dryman/Lyons Dona-Roberts Bays represents a 500 foot linear increase in bulkheading with a larger increase in total shoreline length. These net changes, while small, indicate a measurable decrease in the rate of shoreline hardening. The distribution of secondary bulkhead shorelines is not available from the 1948 aerial-photo inventory and varies little between the 1978 and 1987 inventories (4.61 and 4.75 miles, respectively; Table 2).

The distribution of total reveted (or rip-rap) shorelines for 1978 and 1987 is presented in Figure 6 (1948 data are included in the bulkhead measurements). County-wide, total revetments averaged 10% in 1978 and 14% in 1987. Values between 5 and 10% are common for most areas with notable exceptions along Blackburn/Dryman/Lyons/Dona/Roberts Bays (18% barrier and 33% mainland) and 15% along mainland Sarasota Bay. The Sorrento Shores development on South Creek represents about 45% of all revetment in the County in 1978 and 30% in 1987. The overall increase in revetment is attributed to state and local policies promoting its use (relative to vertical bulkheads; see Review and Evaluation of Laws and Ordinances, page 30).

Secondary revetments represent a relatively small proportion of all shorelines (1% in 1978; 2% in 1987) but have increased at a faster rate than primary revetments (Table 2).

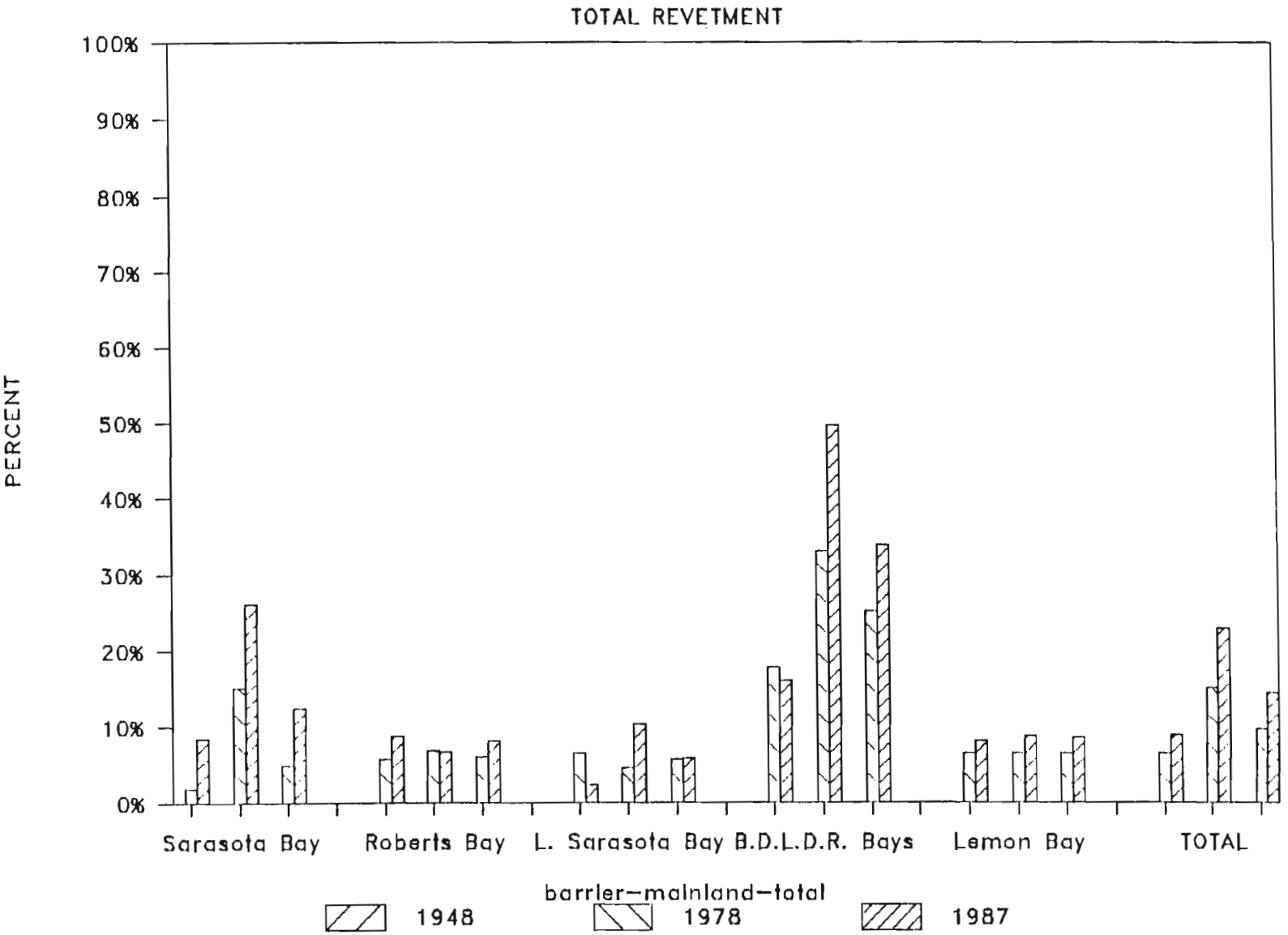


Figure 6. Distribution of total revetments for 1978 and 1986-87.

The distribution and changes of primary mangrove shorelines are approximately the inverse of primary bulkheads (Figures 5-6). In 1948, 60% of the primary shorelines were mangroves with 68% occurring on the barriers and 44% on mainland shorelines. The only exception to mangrove predominance on the barriers is Roberts Bay, where the mangrove forest at the mouth of Phillippi Creek is included in the mainland total.

Sarasota Bay, which had a high percentage of bulkheads in 1948 (>20%) had the lowest proportion of mangrove shorelines in 1948 (33%). This was due to both the high proportion of hardened shorelines and the high energy conditions of the bay which created a large proportion of primary beach (44%). The overall trend of decreasing mangrove distribution from 1948 to 1987 (60 to 37%) is partially offset by a 2% increase in primary mangrove shorelines from 1978 to 1987 (35-37%). Similar increases occur for secondary and total mangrove distribution (Figure 7). It may be significant that secondary mangrove shorelines are increasing at a faster rate than primary mangrove shorelines (Figure 8a-b; 7-11% vs. 35-37%).

The Other Vegetation category is composed of marsh grasses (Juncus roemerianus and Spartina spp.) and other native vegetation (usually secondary species, such as Distichlis spicata, Sesuvium portulacastrum, etc.) The 1987 inventory mapped and measured Juncus and Spartina species independently. These sub-categories were identified individually on the maps but, for measurement purposes, were combined to enable comparison to earlier data. In general, the Other Vegetation category occurs landward or secondary to other shoreline types with the exception of small plots of Juncus roemerianus and Spartina alterniflora).

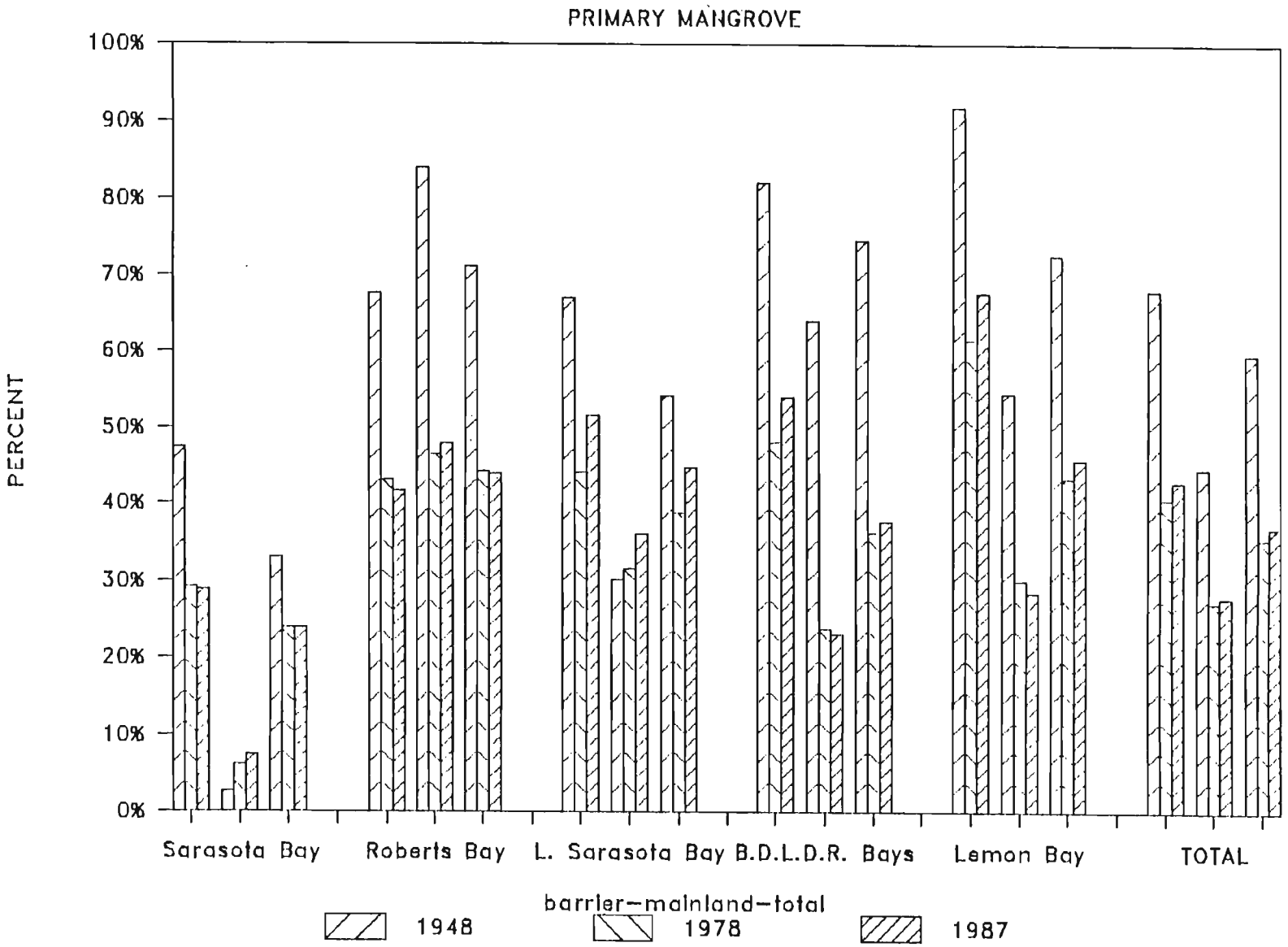
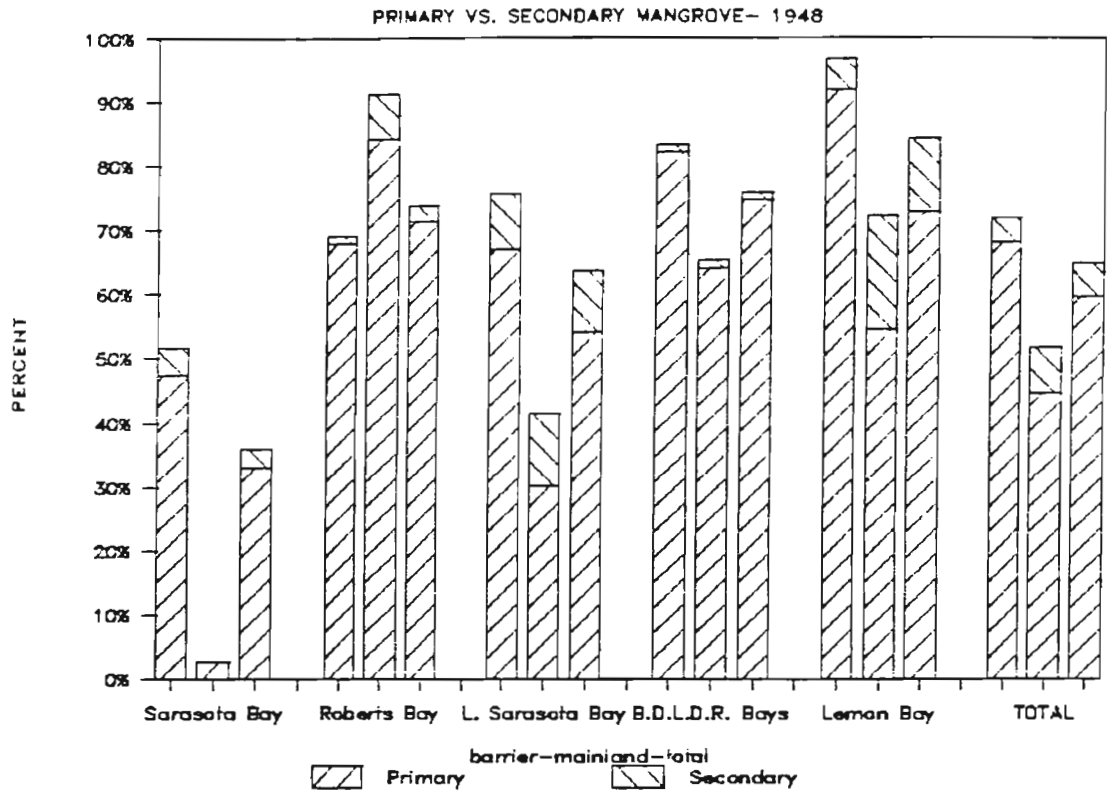


Figure 7. Distribution of mangrove shorelines 1948, 1978, and 1986-87.



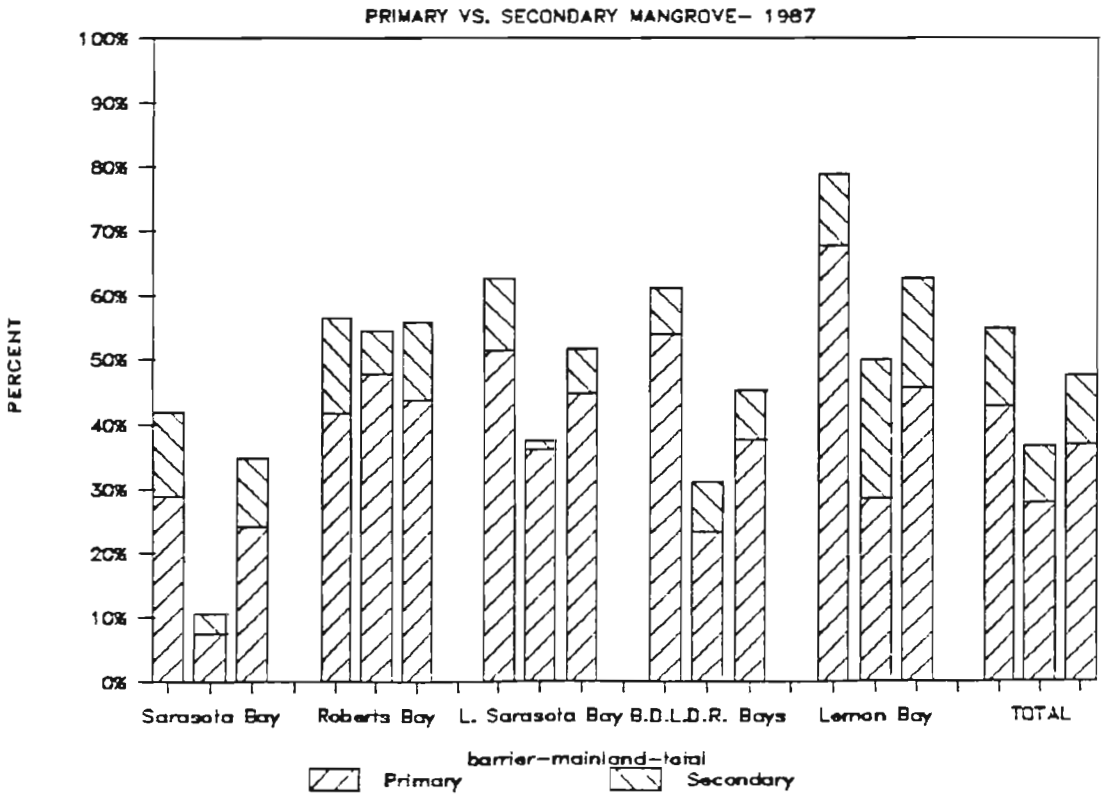


Figure 8. Distribution of primary vs. secondary mangrove shorelines; A) 1948, B) 1986-87.

Other Vegetation as a primary shoreline type occupied between 0 and 21% of 1948 shorelines with an overall total of 5%. These values declined to a 0-11% range in 1978 with 3% overall distribution and 0-10% range with 2% overall in 1987. Other Vegetation occurring as a secondary shoreline type is significantly higher with a 1948 range of 3-42% and an overall distribution of 24% (Figure 9). In 1978, the values declined to a 3-51% range with 17% overall distribution and 1-45% range and 11% overall in 1987.

The Australian Pine/Brazilian Pepper (AP/BP) shorelines were mapped and measured as AP or BP and/or undifferentiated AP/BP. Linear measurements are summed for comparative purposes as in the Other Vegetation category. Also similar to the Other Vegetation category is the predominance of AP/BP shorelines as a secondary shore type, i.e. landward of a primary beach or mangrove fringe.

Primary AP/BP ranged from 0-4% with 1% overall distribution in 1948 and distributions remained at 1% for the 1978 and 1987 inventories with measured length increasing proportionally with total shoreline length. Secondary distributions were much larger and increased with time (0-12%, 3% overall in 1948; 0-19%, 8% overall in 1978 and 2-17%, 12% overall in 1987; Figure 10).

The percentage distribution of Primary AP/BP is somewhat misleading relative to actual occurrence. While overall percentage distribution remained at 1% for each inventory, measured distances varied from 6,660 feet in 1948 to 10,362 feet in 1978 and then declined to 8118 feet in 1987. Length/% measurements of secondary AP/BP are more consistent: 20,592

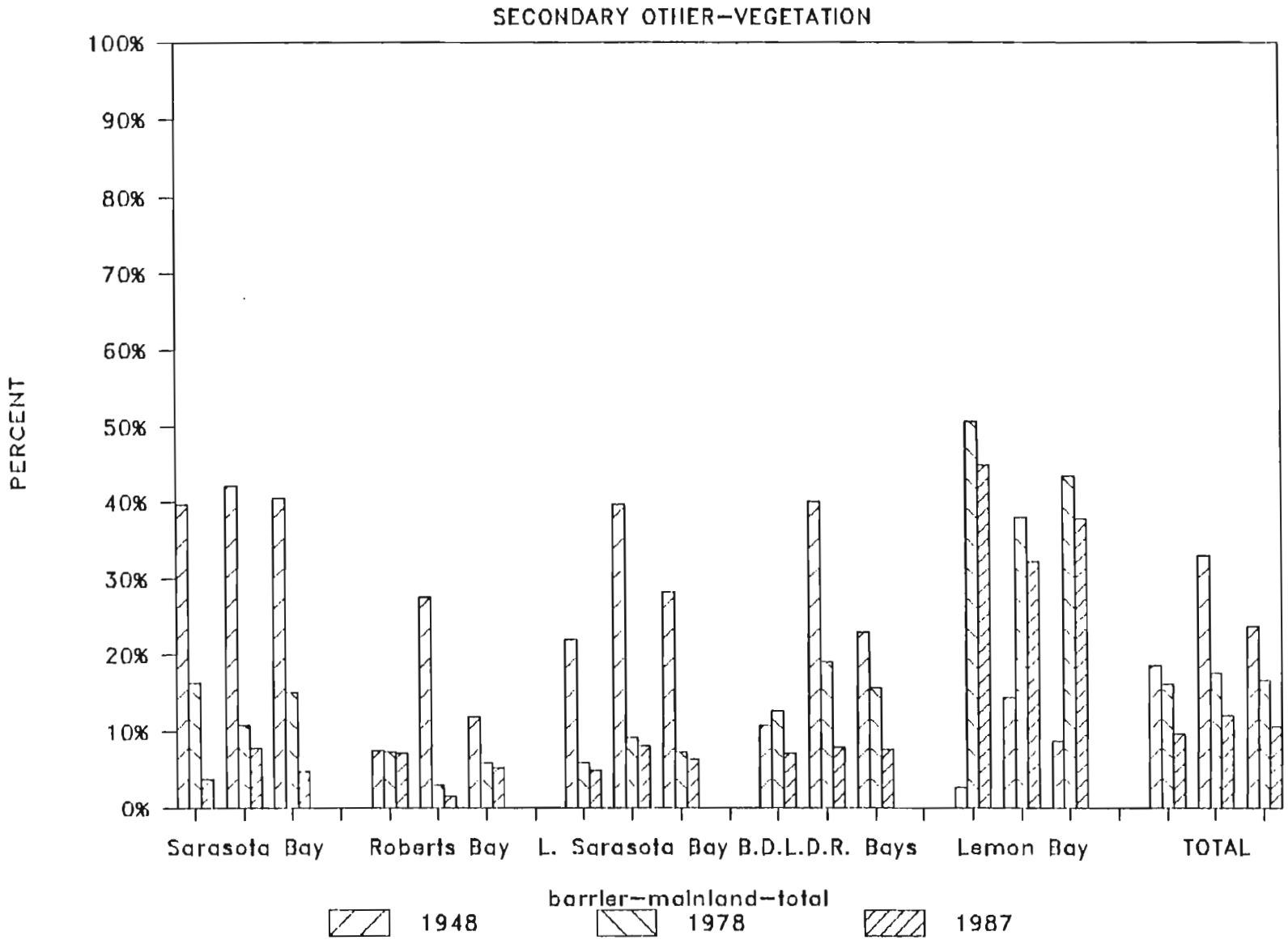


Figure 9. Distribution of secondary other vegetation 1948, 1978, and 1986-87.

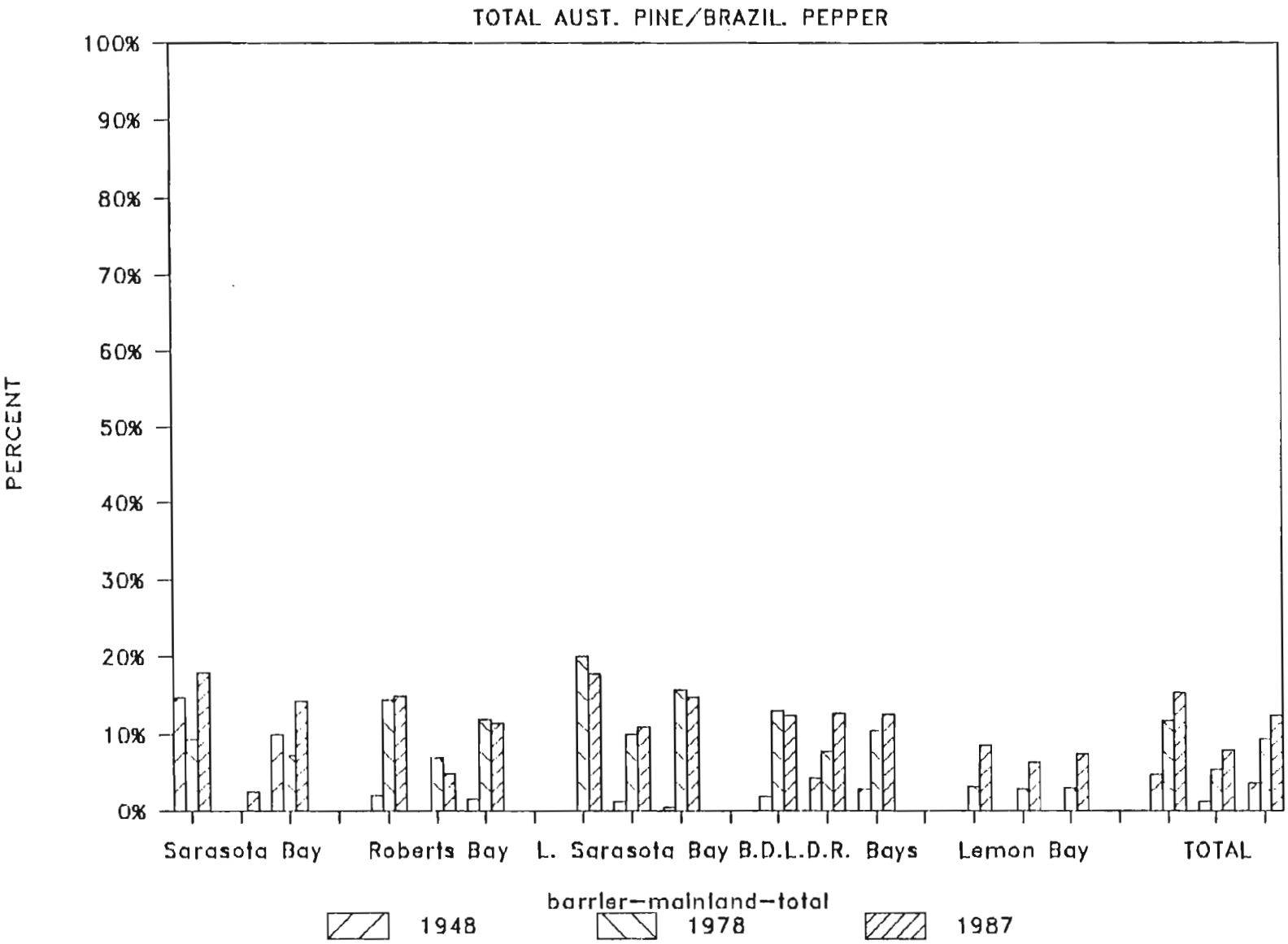


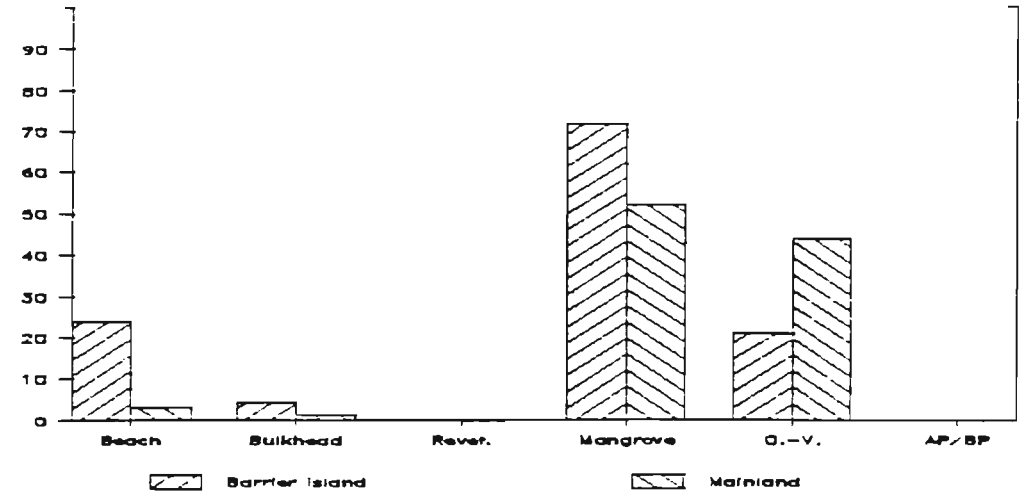
Figure 10. Distribution of total Australian pine and Brazilian pepper 1948, 1978 and 1986-87.

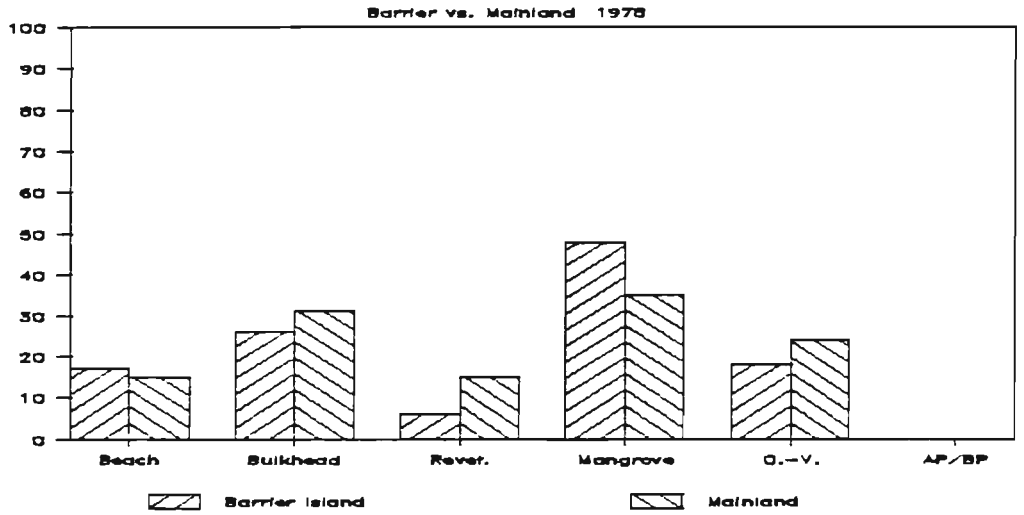
feet/3%; 91,740 feet/8% and 129,954 feet/12% for 1948, 1978 and 1987, respectively.

The overall distribution of AP/BP has increased significantly from 1948 to 1987. This category occurs primarily as a secondary shore type. Its location and increased abundance mirror the decline in the secondary Other Vegetation category. Analysis of the inventory maps do not indicate site specific replacement of Other Vegetation and AP/BP vegetation types. Field and map observations indicate that AP/BP tends to grow rapidly on filled or altered sites and the increase in AP/BP shorelines probably reflects the general increase in disturbed sites.

Figure 11 presents the summary data for each year and shoreline type (total) relative to barrier vs. mainland location. Data show that mainland shores have consistently more hardened structures, more Other Vegetation shorelines, and initially more beach, while barrier shorelines have consistently more mangrove shorelines. These results are indicative of natural variation in shoreline distributions with high energy beaches and mixed shoreline vegetation along mainland shores and the dominance of mangrove vegetation on back-barrier and intra-bay island shorelines.

In summary, the rapid increase in shoreline length and hardened shorelines from 1948 to 1978 was slowed between 1978 to 1987. Likewise, the drastic decrease in mangrove shorelines was reversed with a 2% net increase from 1978 to 1987. Beach and Other Vegetation shorelines had continuous declines from 1948 to 1978 to 1987 while Australian Pine/Brazilian Pepper shorelines showed a continuous increase in distribution.





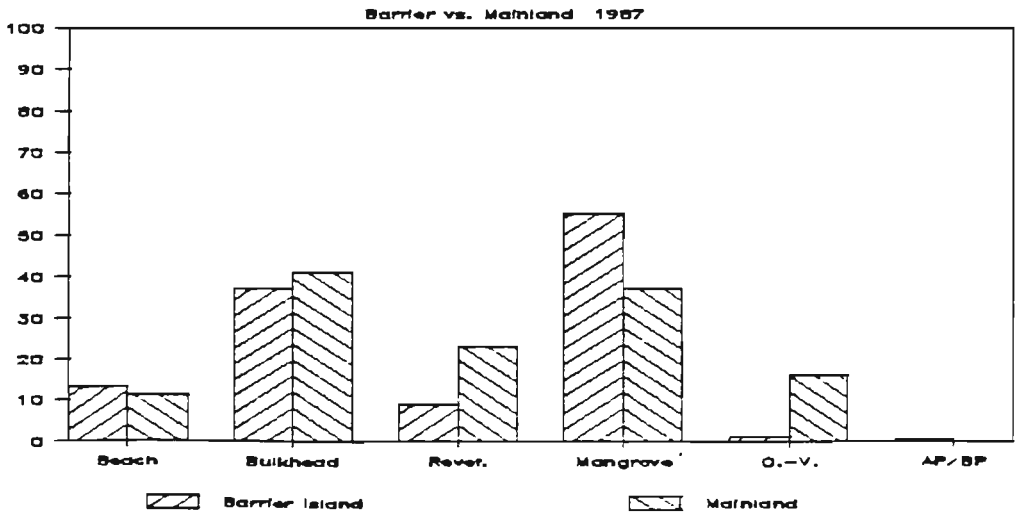


Figure 11. Summary data by year and shoreline type showing barrier vs. mainland location.

DISCUSSION

The shoreline inventories analyzed in this report represent linear estimates of six shore type categories. These categories, including primary and secondary shorelines, quantify the estuarine intertidal zones of Sarasota County. Although the intertidal zone is almost by definition an areal parameter, the fringing nature of Sarasota County shorelines lends itself to linear measurement. Extensive areas of intertidal habitat within the County's bays are limited to discrete areas such as relict flood tidal deltas or overwash areas in backbarrier locations (i.e South Lido, Bird Keys, etc.) and the mouths of tidal creeks (i.e. Phillippi, North Creek, etc.). While linear measurements are probably reliable estimates of the narrow fringing bay shorelines, it should be kept in mind that intertidal area and areal distribution of shore types are the parameters modeled by linear measurement.

The primary use of the estuarine shorelines in Sarasota County is residential development. This development is clearly not dependent upon waterfront location. However, the demand for waterfront homesites is due largely to the aesthetic appeal of waterfront location and vistas which do depend on proximity to the estuarine systems. The value of natural shorelines for habitat, storm buffers and hydrologic continuity is not affected by development except where shoreline vegetation is removed, slopes are altered or hydrologic barriers are erected.

A number of regulations and ordinances (Table 4) have been adopted in order to prevent those deleterious alterations and the results of the preceding sections indicate that management has been effective. However, current regulatory approaches to shoreline management regard the position

Table 4. Primary state rules and local ordinances governing estuarine shoreline alteration.

Regulation/ Governing Agency	Regulated Shoreline Alteration Activity	"Intent" of Regulation
Chpt. 17-4.28, FAC* FDER** adopted: 6/75	dredging/filling prior to 1984	
Chpt. 17-12, FAC* FDER** adopted: 12/84	dredging/filling	implements Henderson Wetland Protection Act of 1984 with intent to preserve and protect "Florida's remaining wetlands to the greatest extent practicable.."
Chpt. 17-27, FAC* FDER** adopted: 5/85	mangrove trimming	"To protect mangroves & their vital role in the economy and ecology of the state..."
Ordinance 72-84 Sarasota County	dredging/filling	"To regulate & control waterways & their alteration in the interest of public rights...& preserve the natural beauty of the waterways..."
Ordinance 81-30 Sarasota County	addresses several policies on shoreline activities as part of Apoxsee, the County's comprehensive land use plan	
Ordinance 83-44	mangrove trimming/ tree removal	requires tree removal permit & states that "mangrove trees are of special ecological value..."

* FAC - Florida Administrative Code
** FDER - Florida Department of Environmental Regulation

of the shoreline and location of the intertidal zone as static features. Analysis of tide gauge data over the past 100 years has indicated a fluctuating rise in sea level with distinct 5-7 year cycles (Figure 12a; Hicks et al, 1983; Gornitz and Lebedeff, 1987).

Predictions of future sea level rise vary considerably (Figure 12b) but there is a consensus of opinion that sea level will continue to rise and that rise will occur at an increasing rate (Hoffman, 1983; Revelle, 1983; Barth and Titus, 1984). The most recent estimates by the U.S. Environmental Protection Agency (1987) indicate that eustatic sea level will be 31 inches (80 cm) higher than present by the year 2100. Earlier estimates of eustatic sea level rise indicated a rise between 20-136 inches depending upon various assumptions, i.e. carbon dioxide production, cloud cover, polar ice melting, etc (Hoffman, 1983). Sea level is projected to increase 5-6 inches above the present level in the next 40 years (which approximates the period of the inventories in this study). Historic sea level rise indicates that sea level was 1-2 inches lower than present in 1948.

In the absence of equal sedimentary accumulation, a 5-6 inch rise in sea level will drown almost all of the intertidal vegetation within the County's bays. Current regulatory procedures do not address a dynamic intertidal zone and the net effect of current policies is to harden the shoreline at the mean high water (mhw) line and effectively isolate the intertidal and supratidal zones. Geologic and historic analyses of coastal environments indicate that wetlands are capable of progressive landward migration in response to sea level rise (Hine et al, in press; DeLaune et

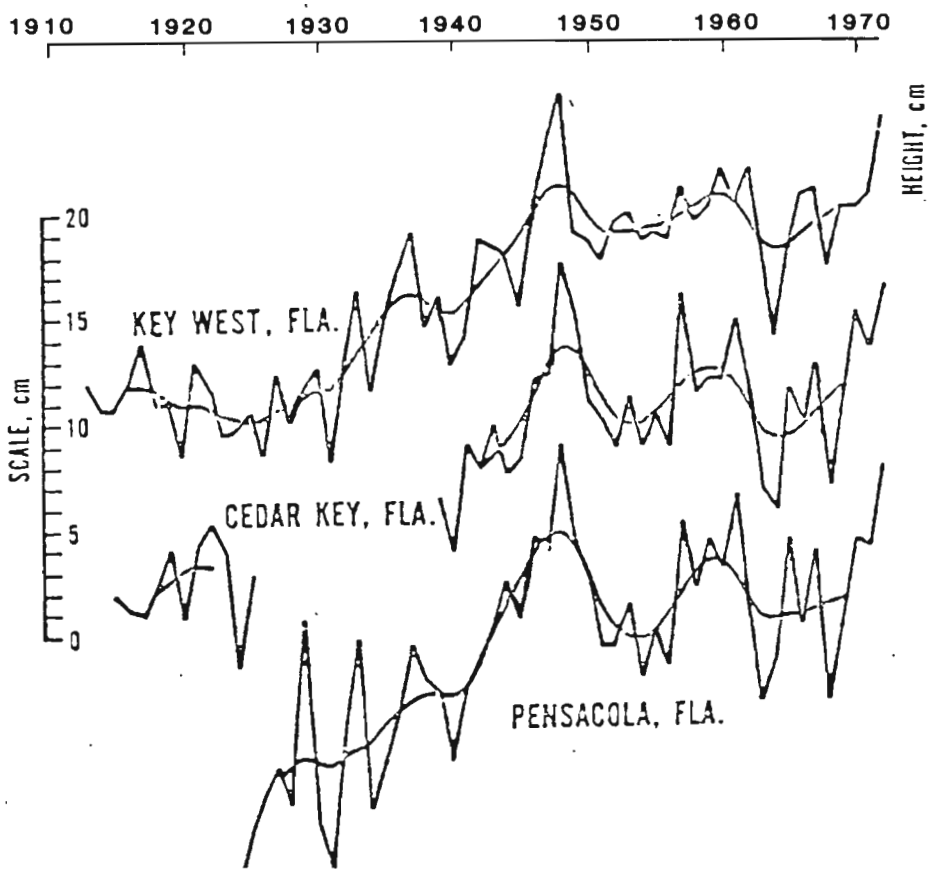


Figure 12A. Tide gauge data for various sites along the Florida coast illustrating sea-level rise over a 50 year time frame. Reference: Hicks et al, 1983.

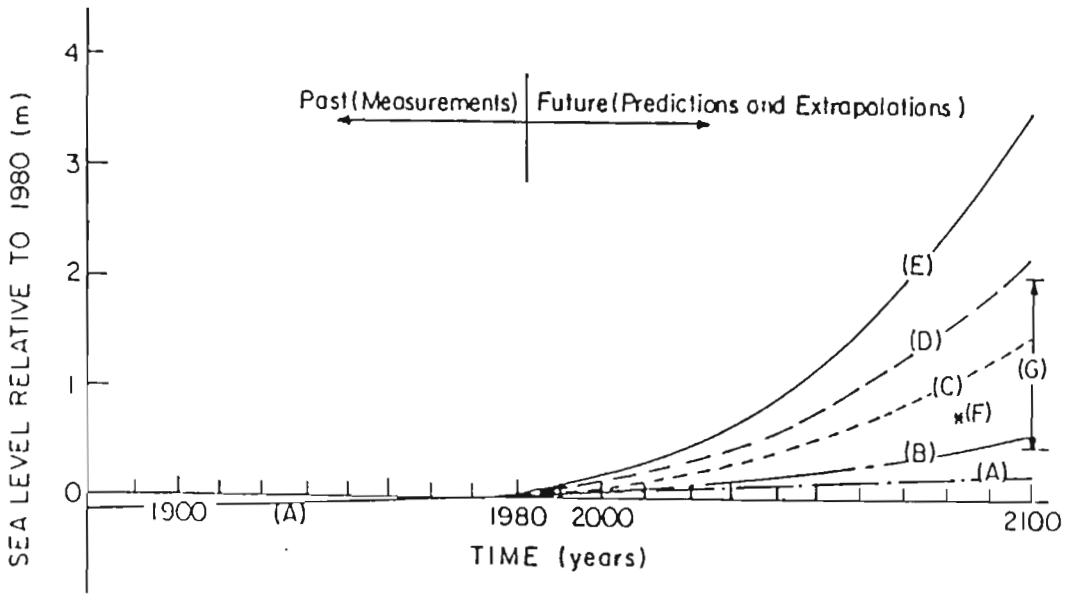


Figure 12B. Eustatic Sea Level Rise. A. Rate over last Century and Projected into Future; B. C. D. & E.EPA 1984 Estimates for Conservative, Mid-Range Low, Mid-Range High and High, Respectively; F. Revelle Estimate; G. Polar Research Board Augmented with Revelle Estimate for Thermal Expansion. References: Revelle, 1983; Hoffman, 1983.

al, 1987; Evans et al, 1985). Shoreline hardening obviously precludes such migration and results in in-place drowning of wetland habitat.

A primary objective of the Evans et al (1978) shoreline inventory was to assess the potential for habitat restoration. One recommendation of that study suggested that the drainage networks into the bays, bayous and creeks be analyzed in regard to stormwater management and habitat creation. In light of an increasing sea level, these areas are the future intertidal zones which suggests the need for integrated stormwater and wetland management.

REVIEW AND EVALUATION OF LAWS AND ORDINANCES GOVERNING ESTUARINE SHORELINE ALTERATION

A variety of federal, state and local laws are now in place which prohibit or greatly curtail the shoreline alteration and resultant degradation which occurred prior to the 1978 shoreline inventory. Although most of the laws were enacted around the time of that inventory, the regulatory process (particularly rule-making, policy formation and development of procedures to carry out enacted laws) is on-going and continuous. However, the shoreline data for 1948, 1978 and 1987 provide discrete measures of change and a yard-stick by which to evaluate the effectiveness of the "intent" of the laws (Table 4).

Physical alterations to shorelines which are regulated include regrading, revegetation, rock revetments, and bulkheads. County permitting regulations and policy separate bulkheads into seawalls and retaining walls based on their location relative to mean sea level (Folit, in press). Mangrove removal and/or trimming is also regulated and may or may not significantly alter the shoreline. The shoreline survey data provide good information on the changes over time for rock revetments, revegetation, seawalls, mangrove removal and for dredging and/or filling activities. Some information is provided on retaining walls where bulkheads are noted as secondary shoreline. The effectiveness of laws governing mangrove trimming and regrading shorelines cannot be evaluated. However, regulations governing mangrove trimming have only recently been enacted (Chapter 17-27, Florida Administrative Code, adopted in 1985) and trimming

mangroves according to these regulations should not change the shoreline type.

Of particular significance, the County now regulates upland coastal projects by requiring permits for activities in upland coastal areas within 20 feet landward of the mean high water line or from the most landward extent of swamp or overflow lands of any bay, bayou, tidal creek, stream, canal, lake or river. These include temporary activities during the construction process which may promote erosion or sediment inadvertently washing into tidal waters or wetlands, the building of permanent structures (such as patios, decks, swimming pools, etc.) and shoreline stabilization structures, such as revetments and retaining walls (Folit, in press). In place since 1972, the regulations require permits and, thereby, provide guidance on construction activities and placement of structures but do not necessarily prohibit them.

Dredge and/or fill activities require federal, state and local permits and, in most cases, any proposal involving new dredging is no longer permitted (Folit, in press). Apoxsee, Sarasota County's Local Government Comprehensive Plan (adopted in 1981), specifically recommends that filling and new dredging be prohibited in bays, bayous, canals, tidal creeks, streams, passes, or swamp and overflow lands. Although maintenance dredging is permissible in some cases, by definition it is not applicable to shoreline cases.

State and federal dredge and fill regulations are covered by a joint permit process which is often lengthy, requiring mitigation and by statute recognizes that Florida's wetlands (and intertidal zones) are a "major

component of the essential characteristics that make this state an attractive place to live."

Chapter 17-12, Florida Administrative Code, further mandates the following policies regarding state dredge and fill activities:

> 1."...To establish reasonable regulatory programs which provide for the preservation and protection of Florida's remaining wetlands to the greatest extent practicable, consistent with private property rights and the balancing of other state vital interests;"
>
> 2."...To consider the extent to which particular disturbances of wetlands are related to uses or projects which must be located within or in close proximity to the wetland and aquatic environment in order to perform their basic functions, and the extent to which particular disturbances of wetlands benefit essential economic development."

Increases in shoreline length can primarily be attributed to dredging and/or filling since the location of estuarine shorelines does not significantly change under natural conditions during short time periods. The estuarine shorelines of Sarasota County increased by 1.4 miles from 1978 to 1987 indicating some shoreline modification due to dredging. The major areas of extensive shoreline modification occurred where small canals were created or enlarged in Blackburn, Dryman, Lyons, and Dona-Roberts Bays (Table 2). However, this is relatively insignificant since it is only a 1% change in overall shoreline length as compared to a 43% increase (62.8 miles) from 1948 to 1978.

A county permit is required for shoreline alterations that regrade and/or revegetate the shoreline, or repair, replace or build a new shoreline structure (i.e. rock revetment, retaining wall or seawall).

The following general guidelines apply (Folit, in press);

"-Generally, the ideal shoreline, from a coastal zone management standpoint, is one which is gently sloping and vegetated with native wetland and aquatic plants. This provides habitat for marine life, minimizes shoreline erosion, maintains water quality, and recycles nutrients within the water body. Thus, vegetating the shoreline with native aquatic and wetland plants and, if necessary, regrading to a gentle slope is highly recommended as a means of shoreline protection."

"-'Hardening' the shoreline with coastal structures is generally not encouraged, because such structures not only reduce productive shoreline areas, but may also offer only minimal property protection. However, if you believe you need a coastal structure to protect you property, it is permissible in certain locations. Generally, rock revetments (also called riprap) are preferable to retaining walls, which are preferable to seawalls."

"-A Proposed shoreline structure where either or both of the adjacent shorelines are <u>not</u> hardened, must be set back four to eight feet from mean high water (MHW), and wetland vegetation must be planted seaward of the structure."

"- Fill must not erode or otherwise be placed seaward of mean high water (MHW). In construction of a coastal structure, filter cloth must be placed between the soil and the structure to prevent erosion of the underlying soil."

"-Because shoreline structures generally remove valuable shore habitat, mitigating action such as revegetation is often required as a stipulation for obtaining a permit. Revegetation is mandatory if plants are destroyed during construction of a coastal structure. Existing mangroves or other littoral zone plants must not be destroyed."

"-Contact the Coastal Zone Division regarding any activity within 20 feet of mean high water or swamp and overflow lands to confirm whether permits are required."

For seawalls, the repair, replacement or new construction is currently permitted only on man-made canals occupied wholly or in part by seawalls and a county "minor" work permit is required (County Ordinance 72-84). Under this ordinance, no new seawalls or replacement of existing seawalls are permissible along bays, bayous, tidal creeks and rivers. However, minor work permits can be obtained to replace a seawall with a rock revetment or a retaining wall/revetment combination.

State agency permits are required for revetments, retaining walls and seawalls (except where seawalls are repaired or replaced within the boundaries of an existing seawall).

County policy and regulations clearly delineate the difference between seawalls and retaining walls, with the former prohibited in most locations. The shoreline survey provides data on bulkheads without distinguishing the difference. However, by definitions a retaining wall must occur above the mean high water line and thus would occur only as a secondary shoreline type. (Either a beach or other shoreline type would have to be in front.) Because seawalls are vertical structures occurring below the mean high water line, they severely limit the intertidal zone and their use has been curtailed since the 1978 study (Figure 5). Shoreline data indicate a slight increase in both primary and secondary bulkheads but the changes are too small to reveal any differences resulting from County policy regarding seawalls vs. retaining walls.

However, while county policy and regulations may discourage the use of revetments and revetment/retaining wall combinations, their use is still permitted. Data show that this has been a relatively common practice with an overall countywide increase of more than nine miles (4%) of revetments. Revetments allow for some intertidal area and mangroves often colonize these areas. However, revetments are commonly designed for 3:1 slopes limiting the areal extent of the possible intertidal zone.

Currently, there is a lack of consistency regarding the definition of the mean high water line during the permitting process. Due to sea level rise, the mean high water line has changed over time (and will continue to do so). Permit applicants use a variety of methods to determine mean high

water line and, while each is a valid measurement, the results from differing methodologies can vary significantly. Some may use the 1929 benchmarks for determining mean sea level (msl) while others use determinations based on modern surveys. A county-sponsored resurvey and official benchmarks based on current data could clarify this problem.

Current planning and permitting practices do not consider the effects of long-term sea level rise on shoreline protection and whether protection measures will maintain an intertidal zone in the future (Figure 12). T o date, no regulations or policies directly address the significance of all intertidal areas but do so implicitly by trying to maintain wetland habitats which are intertidal. While it is the habitats which are important for the functioning of the estuary, it may be the barren intertidal and transitional areas that will replace important habitats naturally in the context of future sea level rise. The county's practice of regulating activities within a 20 foot buffer strip of the shoreline is a start towards maintaining the long-term integrity of the intertidal zone.

SUMMARY AND RECOMMENDATIONS

Analysis of shoreline data for 1986-87 shows a marked drop in the rate of shoreline alterations from a previous shoreline study conducted in 1978 (Evans et al, 1978). This indicates that laws and ordinances enacted in the last 10-15 years have effectively preserved important estuarine habitat by limiting shoreline alteration.

However, four factors may limit the effectiveness of current regulatory practices. The first factor, the virtual absence of active restoration programs, limits the role of estuarine habitats in maintaining the overall health of the bay systems. Without marked improvements by providing new estuarine habitat, degradation resulting from historical shoreline modifications will continue although the rate of degradation has been curtailed.

The second factor limiting the effectiveness of current regulatory practices is the rapid rate of shoreline development above the mean high water line. The continued increase in hardened secondary shorelines is of particular significance, especially where shoreline slope has been increased above the mean high water line or where native vegetation has been removed. Upland development can also alter the hydrologic regime of an area by changing runoff conditions. The effectiveness of the shoreline for buffering storms may also be reduced.

The third factor limiting regulatory efforts is the difficulty with identifying and controlling cumulative impacts from shoreline alterations. There is a need to evaluate each small "backyard" alteration in the context

of the overall estuary and its watershed. Individually, each alteration may have a limited impact on the estuary but the cumulative impacts from a number of small alterations can have a tremendous impact over time. Methods for identifying and controlling cumulative impacts are difficult to develop and implement because a holistic view and understanding of the entire system and its processes is required. However, it can be accomplished with an on-going planning and management program.

The fourth factor, historical and projected sea level changes, must be addressed. Current regulatory approaches to shoreline management regard the position of the shoreline and location of the intertidal zone as static features. The most recent projections for sea level rise indicate that eustatic sea level will be 5-6 inches higher than present by the year 2048 (U.S. Environmental Protection Agency, 1987). With the current level of upland development, little room will be available for retreating natural shorelines. The result may be in-place "drowning" and long-term loss of important intertidal habitat over the life expectancy of current projects.

The following recommendations address these concerns and are based on shoreline information gathered as part of this study:

Recommendation 1: Begin an active program to restore native wetland habitats.

In the past ten years, it has been a policy to protect and conserve all native habitats. Since a large portion of native shoreline habitats has been reduced or altered to some degree, it is recommended that restoration of native shoreline habitats begin. This could be accomplished by:

--Implementing a shoreline impact fee as part of the County permit procedures to help fund a wetland management and restoration program.

--Integrating stormwater management and wetland management/restoration programs.

--Establishing specific goals for restoration; i.e. 300 acres by the year 2000.

--Encouraging the adoption of a gill net license fee for county restoration projects and encouraging the adoption of a statewide saltwater fishing license.

Recommendation 2: Adopt policies prohibiting any decreases in intertidal areas and requiring that mitigation result in increased intertidal areas.

Recommendation 3: Incorporate historic and predicted sea level rise information and projected shoreline changes into planning and regulatory procedures.

Under current policy, long-term wetland habitat loss is predicted due to sea level rise and current practices for revetments, retaining walls and upland filling of land. Reducing the negative effects of sea level rise and predicting resultant changes can be accomplished by:

--Developing a research/monitoring program to evaluate and modify sea level rise studies and to evaluate the ability of fringe habitats to aggrade upward in response to sea level rise.

--Focusing restoration efforts on fresh to brackish water systems along the upland margins and drainage systems.

--Basing all permit decisions on a consistent, clearly defined mean high or mean higher high water line. Establish consistency via a county-sponsored resurvey of official benchmarks.

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APPENDIX I

SUMMARY DATA MATRIX

SHORELINE DATA WORKSHEET

			beach primary feet	percent	beach secondary feet	percent	beach total feet	percent
1948	Sarasota Bay	barrier	59938	45%	0	0%	59938	45%
		mainland	26994	43%	0	0%	26994	43%
		total	85932	44%	0	0%	85932	44%
1948	Roberts Bay	barrier	23298	20%	0	0%	23298	20%
		mainland	3828	12%	0	0%	3828	12%
		total	27126	18%	0	0%	27126	18%
1948	L. Sarasota Bay	barrier	27390	31%	0	0%	27390	31%
		mainland	24816	52%	1320	3%	26136	55%
		total	52206	38%	1320	1%	53526	39%
1948	B.D.L.D.R. Bays	barrier	6666	7%	0	0%	6666	7%
		mainland	4752	7%	0	0%	4752	7%
		total	11418	7%	0	0%	11418	7%
1948	Lemon Bay	barrier	4686	8%	0	0%	4686	8%
		mainland	21912	34%	0	0%	21912	34%
		total	26598	21%	0	0%	26598	21%
1948	TOTAL	barrier	120978	24%	0	0%	120978	24%
		mainland	82302	30%	1320	0%	83622	30%
		total	203280	26%	1320	0%	204600	26%
1978	Sarasota Bay	barrier	48510	18%	0	0%	48510	18%
		mainland	14520	18%	0	0%	14520	18%
		total	63030	18%	0	0%	63030	18%
1978	Roberts Bay	barrier	19536	14%	0	0%	19536	14%
		mainland	1848	3%	0	0%	1848	3%
		total	21384	10%	0	0%	21384	10%
1978	L. Sarasota Bay	barrier	23562	26%	396	0%	23958	27%
		mainland	6534	10%	0	0%	6534	10%
		total	30096	19%	396	0%	30492	19%
1978	B.D.L.D.R. Bays	barrier	5676	5%	0	0%	5676	5%
		mainland	14652	15%	0	0%	14652	15%
		total	20328	10%	0	0%	20328	10%
1978	Lemon Bay	barrier	17622	24%	0	0%	17622	24%
		mainland	25938	26%	0	0%	25938	26%
		total	43560	25%	0	0%	43560	25%
1978	TOTAL	barrier	114906	17%	0	0%	115302	17%
		mainland	63492	15%	0	0%	63492	15%
		total	178398	16%	0	0%	178794	16%
1987	Sarasota Bay	barrier	32538	12%	0	0%	32538	12%
		mainland	10494	13%	0	0%	10494	13%
		total	43032	13%	0	0%	43032	13%
1987	Roberts Bay	barrier	18612	13%	0	0%	18612	13%
		mainland	1584	2%	0	0%	1584	2%
		total	20196	9%	0	0%	20196	9%
1987	L. Sarasota Bay	barrier	17358	20%	0	0%	17358	20%
		mainland	5676	8%	0	0%	5676	8%
		total	23034	15%	0	0%	23034	15%
1987	B.D.L.D.R. Bays	barrier	5016	5%	0	0%	5016	5%
		mainland	6204	5%	0	0%	6204	5%
		total	11220	5%	0	0%	11220	5%
1987	Lemon Bay	barrier	10956	15%	0	0%	10956	15%
		mainland	22308	24%	0	0%	22308	24%
		total	33264	20%	0	0%	33264	20%
1987	TOTAL	barrier	84480	13%	0	0%	84480	13%
		mainland	46266	11%	0	0%	46266	11%
		total	130746	12%	0	0%	130746	12%

bulkhead primary feet	percent	bulkhead secondary feet	percent	bulkhead total feet	percent	revetment primary feet	percent	revetment secondary feet	percent
5214	4%	0	0%	5214	4%	n/a	n/a	n/a	n/a
33990	54%	0	0%	33990	54%	n/a	n/a	n/a	n/a
39204	20%	0	0%	39204	20%	n/a	n/a	n/a	n/a
9768	8%	0	0%	9768	8%	n/a	n/a	n/a	n/a
0	0%	0	0%	0	0%	n/a	n/a	n/a	n/a
9768	6%	0	0%	9768	6%	n/a	n/a	n/a	n/a
330	0%	0	0%	330	0%	n/a	n/a	n/a	n/a
660	1%	0	0%	660	1%	n/a	n/a	n/a	n/a
990	1%	0	0%	990	1%	n/a	n/a	n/a	n/a
9240	10%	0	0%	9240	10%	n/a	n/a	n/a	n/a
3432	5%	0	0%	3432	5%	n/a	n/a	n/a	n/a
12672	8%	0	0%	12672	8%	n/a	n/a	n/a	n/a
0	0%	0	0%	0	0%	n/a	n/a	n/a	n/a
330	1%	0	0%	330	1%	n/a	n/a	n/a	n/a
330	0%	0	0%	330	0%	n/a	n/a	n/a	n/a
24552	5%	0	0%	24552	5%	n/a	n/a	n/a	n/a
38412	14%	0	0%	38412	14%	n/a	n/a	n/a	n/a
62964	8%	0	0%	62964	8%	n/a	n/a	n/a	n/a
127116	48%	1155	0%	128271	48%	5544	2%	528	1%
44814	57%	10032	13%	54846	70%	11352	14%	4158	17%
171930	50%	11187	3%	183117	53%	16896	5%	4686	5%
47190	33%	2970	2%	50160	35%	7062	5%	858	1%
30294	42%	1056	1%	31350	43%	1452	2%	3498	5%
77484	36%	4026	2%	81510	38%	8514	4%	4356	2%
20196	22%	2904	3%	23100	26%	5148	6%	660	1%
32934	48%	2838	4%	35772	52%	3036	4%	66	0%
53130	34%	5742	4%	58872	37%	8184	5%	726	0%
28050	26%	1254	1%	29304	28%	18810	18%	0	0%
26532	26%	1848	2%	28380	28%	31152	31%	2178	2%
54582	26%	3102	1%	57684	28%	49962	24%	2178	1%
5874	8%	0	0%	5874	8%	3828	5%	858	1%
27456	27%	264	0%	27720	28%	6006	6%	528	1%
33330	19%	264	0%	33594	19%	9834	6%	1386	1%
228426	34%	8283	1%	236709	35%	40392	6%	2904	0%
162030	38%	16038	4%	178068	42%	52998	13%	10428	2%
390456	36%	24321	2%	414777	38%	93390	9%	13332	1%
129624	49%	2178	1%	131802	50%	20262	8%	1650	1%
43692	56%	11418	15%	55110	71%	15378	20%	4950	6%
173316	51%	13596	4%	186912	55%	35640	10%	6600	2%
52668	37%	2640	2%	55308	39%	10032	7%	2376	2%
31812	42%	264	0%	32076	42%	2640	3%	2442	3%
84480	39%	2904	1%	87384	40%	12672	6%	4818	2%
23430	26%	462	1%	23892	27%	1650	2%	396	0%
31284	45%	2310	3%	33594	48%	5544	8%	1650	2%
54714	35%	2772	2%	57486	36%	7194	5%	2046	1%
27984	26%	1452	1%	29436	27%	16302	15%	990	1%
27390	23%	3498	3%	30888	26%	54054	45%	5742	5%
55374	24%	4950	2%	60324	27%	70356	31%	6732	3%
6468	9%	66	0%	6534	9%	5214	7%	792	1%
28116	30%	792	1%	28908	31%	7458	8%	726	1%
34584	21%	858	1%	35442	21%	12672	8%	1518	1%
240174	36%	6798	1%	246972	37%	53460	8%	6204	1%
162294	37%	18282	4%	180576	41%	85074	19%	16830	4%
402468	36%	25080	2%	427548	38%	138534	12%	21714	2%

revetment total		mangrove primary		mangrove secondary		mangrove total		other-vege primary
feet	percent	feet	percent	feet	percent	feet	percent	feet
n/a	n/a	62634	47%	5544	4%	68178	52%	2179
n/a	n/a	1650	3%	0	0%	1650	3%	0
n/a	n/a	64284	33%	5544	3%	69828	36%	2178
n/a	n/a	80124	68%	1452	1%	81576	69%	4752
n/a	n/a	27786	84%	2310	7%	30096	91%	1452
n/a	n/a	107910	71%	3762	2%	111672	74%	6204
n/a	n/a	59598	67%	7590	9%	67188	76%	1584
n/a	n/a	14256	30%	5346	11%	19602	41%	7722
n/a	n/a	73854	54%	12936	9%	86790	64%	9306
n/a	n/a	79134	82%	1122	1%	80256	83%	924
n/a	n/a	44088	64%	924	1%	45012	65%	14190
n/a	n/a	123222	75%	2046	1%	125268	76%	15114
n/a	n/a	56166	92%	3036	5%	59202	97%	330
n/a	n/a	35178	54%	11418	18%	46596	72%	7194
n/a	n/a	91344	73%	14454	11%	105798	84%	7524
n/a	n/a	337656	68%	18744	4%	356400	72%	9768
n/a	n/a	122958	44%	19998	7%	142956	52%	30558
n/a	n/a	460614	60%	38742	5%	499356	65%	40326
6072	2%	77484	29%	1386	1%	78870	30%	1584
15510	15%	4818	6%	1188	2%	6006	8%	3234
21582	5%	82302	24%	2574	1%	84876	25%	4818
7920	6%	61050	43%	16698	12%	77748	55%	6600
4950	7%	33792	46%	2838	4%	36630	50%	3894
12870	6%	94842	44%	19536	9%	114378	53%	10494
5808	6%	39600	44%	13134	15%	52734	59%	132
3102	5%	21582	32%	2640	4%	24222	35%	4092
8910	6%	61182	39%	15774	10%	76956	49%	4224
18810	18%	50952	48%	8382	8%	59334	56%	1386
33330	33%	23892	24%	7656	8%	31548	31%	4554
52140	25%	74844	36%	16038	8%	90882	44%	5940
4686	6%	45078	62%	7788	11%	52866	72%	858
6534	7%	30030	30%	20790	21%	50820	51%	10560
11220	6%	75108	43%	28578	16%	103686	60%	11418
43296	6%	274164	41%	47388	7%	321552	48%	10560
63426	15%	114114	27%	35112	8%	149226	35%	26334
106722	10%	388278	35%	82500	8%	470778	43%	36894
21912	8%	75768	29%	34320	13%	110088	42%	330
20328	26%	5808	7%	2376	3%	8184	11%	2442
42240	12%	81576	24%	36696	11%	118272	35%	2772
12408	9%	59268	42%	21318	15%	80586	57%	1518
5082	7%	36432	48%	5082	7%	41514	54%	2178
17490	8%	95700	44%	26400	12%	122100	56%	3696
2046	2%	45540	51%	10032	11%	55572	63%	0
7194	10%	25080	36%	990	1%	26070	37%	1188
9240	6%	70620	45%	11022	7%	81642	52%	1188
17292	16%	57816	54%	7854	7%	65670	61%	0
59796	50%	27852	23%	9570	8%	37422	31%	4356
77088	34%	85668	38%	17424	8%	103092	45%	4356
8006	8%	49830	68%	8118	11%	57948	79%	1056
8184	9%	26532	29%	20394	22%	46926	50%	9174
14190	8%	76362	46%	28512	17%	104874	63%	10230
59664	9%	288222	43%	81642	12%	369864	55%	2904
106564	23%	121704	28%	38412	9%	160116	37%	19338
160248	14%	409926	37%	120054	11%	529980	48%	22242

tation	other-vegetation secondary		other-vegetation total		AP/BP primary		AP/BP secondary	
percent	feet	percent	feet	percent	feet	percent	feet	percent
2%	52404	40%	54582	41%	3234	2%	16236	12%
0%	26400	42%	26400	42%	0	0%	0	0%
1%	78804	40%	80982	42%	3234	2%	16236	8%
4%	8844	7%	13596	11%	462	0%	1914	2%
4%	9108	28%	10560	32%	0	0%	0	0%
4%	17952	12%	24156	16%	462	0%	1914	1%
2%	19536	22%	21120	24%	0	0%	0	0%
16%	18810	40%	26532	56%	0	0%	594	1%
7%	38346	28%	47652	35%	0	0%	594	0%
1%	10362	11%	11286	12%	396	0%	1452	2%
21%	27588	40%	41778	61%	2508	4%	396	1%
9%	37950	23%	53064	32%	2904	2%	1848	1%
1%	1584	3%	1914	3%	0	0%	0	0%
11%	9372	15%	16566	26%	0	0%	0	0%
6%	10956	9%	18480	15%	0	0%	0	0%
2%	92730	19%	102498	21%	4092	1%	19602	4%
11%	91278	33%	121836	44%	2508	1%	990	0%
5%	184008	24%	224334	29%	6600	1%	20592	3%
1%	43494	16%	45078	17%	5742	2%	19206	7%
4%	8514	11%	11748	15%	0	0%	0	0%
1%	52008	15%	56826	16%	5742	2%	19206	6%
5%	10296	7%	16896	12%	132	0%	20394	14%
5%	2112	3%	6006	8%	1584	2%	3432	5%
5%	12408	6%	22902	11%	1716	1%	23826	11%
0%	5280	6%	5412	6%	1188	1%	16764	19%
6%	6270	9%	10362	15%	66	0%	6732	10%
3%	11550	7%	15774	10%	1254	1%	23496	15%
1%	13398	13%	14784	14%	1188	1%	12606	12%
5%	19206	19%	23760	24%	66	0%	7788	8%
3%	32604	16%	38544	19%	1254	1%	20394	10%
1%	37026	51%	37884	52%	0	0%	2310	3%
11%	38148	38%	48708	49%	396	0%	2508	2%
7%	75174	43%	86592	50%	396	0%	4818	3%
2%	109494	16%	120054	18%	8250	1%	71280	11%
6%	74250	18%	100584	24%	2112	1%	20460	5%
3%	183744	17%	220638	20%	10362	1%	91740	8%
0%	9900	4%	10230	4%	4158	2%	42966	16%
3%	6006	8%	8448	11%	0	0%	1914	2%
1%	15906	5%	18678	5%	4158	1%	44880	13%
1%	10164	7%	11682	8%	132	0%	21054	15%
3%	1122	1%	3300	4%	1584	2%	2178	3%
2%	11286	5%	14982	7%	1716	1%	23232	11%
0%	4356	5%	4356	5%	528	1%	15180	17%
2%	5676	8%	6864	10%	858	1%	6732	10%
1%	10032	6%	11220	7%	1386	1%	21912	14%
0%	7590	7%	7590	7%	132	0%	13134	12%
4%	9504	8%	13860	12%	528	0%	14718	12%
2%	17094	8%	21450	9%	660	0%	27852	12%
1%	33000	45%	34056	46%	0	0%	6336	9%
10%	30228	32%	39402	42%	198	0%	5742	6%
6%	63228	38%	73458	44%	198	0%	12078	7%
0%	65010	10%	67914	10%	4950	1%	98670	15%
4%	52536	12%	71874	16%	3168	1%	31284	7%
2%	117546	11%	139788	13%	8118	1%	129954	12%

AP/BP total feet	percent	Total Shoreline Feet	Miles			
19470	15%	132,198	25.04	barrier		
0	0%	62,634	11.86	mainland	Sarasota Bay	1948
19470	10%	194,832	36.90	total		
2376	2%	118,404	22.43	barrier		
0	0%	33,066	6.26	mainland	Roberts Bay	1948
2376	2%	151,470	28.69	total		
0	0%	88,902	16.84	barrier		
594	1%	47,454	8.99	mainland	L. Sarasota Bay	1948
594	0%	136,356	25.83	total		
1848	2%	96,360	18.25	barrier		
2904	4%	68,970	13.06	mainland	B.D.L.D.R. Bays	1948
4752	3%	165,330	31.31	total		
0	0%	61,182	11.59	barrier		
0	0%	64,614	12.24	mainland	Lemon Bay	1948
0	0%	125,796	23.83	total		
23694	5%	497,046	94.14	barrier		
3498	1%	276,738	52.41	mainland	TOTAL	1948
27192	4%	773,784	146.55	total		
24948	9%	265,980	50.38	barrier		
0	0%	78,738	14.91	mainland	Sarasota Bay	1978
24948	7%	344,718	65.29	total		
20526	14%	141,570	26.81	barrier		
5016	7%	72,864	13.80	mainland	Roberts Bay	1978
25542	12%	214,434	40.61	total		
17952	20%	89,826	17.01	barrier		
6798	10%	68,244	12.93	mainland	L. Sarasota Bay	1978
24750	16%	158,070	29.94	total		
13794	13%	106,062	20.09	barrier		
7854	8%	100,848	19.10	mainland	B.D.L.D.R. Bays	1978
21648	10%	206,910	39.19	total		
2310	3%	73,260	13.88	barrier		
2904	3%	100,386	19.01	mainland	Lemon Bay	1978
5214	3%	173,646	32.89	total		
79530	12%	676,698	128.16	barrier		
22572	5%	421,080	79.75	mainland	TOTAL	1978
102102	9%	1,097,778	207.91	total		
47124	18%	262,680	49.75	barrier		
1914	2%	77,814	14.74	mainland	Sarasota Bay	1987
49038	14%	340,494	64.49	total		
21186	15%	142,230	26.94	barrier		
3762	5%	76,230	14.44	mainland	Roberts Bay	1987
24948	11%	218,460	41.38	total		
15708	18%	88,506	16.76	barrier		
7590	11%	69,630	13.19	mainland	L. Sarasota Bay	1987
23298	15%	158,136	29.95	total		
13266	12%	107,250	20.31	barrier		
15246	13%	120,384	22.80	mainland	B.D.L.D.R. Bays	1987
28512	13%	227,634	43.11	total		
6336	9%	73,524	13.93	barrier		
5940	6%	93,786	17.76	mainland	Lemon Bay	1987
12276	7%	167,310	31.69	total		
103620	15%	674,190	127.69	barrier		
34452	8%	437,844	82.93	mainland	TOTAL	1987
138072	12%	1,112,034	210.61	total		