11.0 MODEL TESTING, RESULTS, AND REFINEMENTS

11.1 Overview

The main objective of the test was to ensure that the model successfully executed all the analyses developed for this study. The initial tests of the model also provided an opportunity to identify areas were refinements were necessary. This section of the report focuses on the results of the initial test run and identifies areas that have been refined based on extensive review by the technical contractor, as well as comments from the government study team, the NAS, and others. Computer programming continues in order to incorporate refinements into the overall CCIAM. Key revisions have been completed for the marine module (which was subsequently removed from the CCIAM), indirect and secondary terrestrial impacts, the addition of several threatened species, incorporation of Census 2000 data, incorporation of an existing hurricane evacuation model, revisions to the traffic component, and incorporation of land acquisition costs to the fiscal module. The effects of these refinements are discussed.

11.2 Selection of Test Scenarios

The CCIAM evaluates the effects of land development scenarios and addresses whether scenarios may exceed carrying capacity indicators. The CCIAM's GUI allows users to input land development scenarios based on a series of menu options for relevant parameters. Monthly working sessions between Study Team members and local planners were held in 2000 and 2001. These meetings often addressed scenarios that could or should be evaluated in the CCIAM. From June through August 2001, the Working Group held three workshops to discuss and select scenarios to be used to test the CCIAM. While several primary scenarios were discussed to test the CCIAM, two scenarios were selected: current conditions and a scenario termed "smart growth." These scenarios were 'translated' into menu options on the GUI so that they could be input into the CCIAM.

11.2.1 Current Conditions Scenario

A "current conditions scenario" was selected primarily to test the CCIAM's ability to describe the existing conditions in the Florida Keys, based on input from the existing data sets. This analysis provides a means to complete preliminary calibrations of the model as well as to check the inner workings of the model. The scenario was defined as the current land use pattern in the Florida Keys based on the Monroe County parcel layer.

11.2.2 "Smart Growth" Scenario

The "smart growth" scenario was provided by the Monroe County local planners, and then translated for input into the CCIAM. The scenario represents a moderate development scheme, in which future growth and development are intended to preserve the natural environment, redevelop blighted commercial and residential areas, reduce sprawl, and direct future growth to appropriate infill areas rather than to development of new parcels. The smart growth scenario, as provided by the Working Group, is described below:

> *"A Smart Growth initiative will be implemented in Monroe County to preserve the natural environment, redevelop blighted commercial and residential areas, remove barriers to innovative design concepts, reduce sprawl and direct future growth to appropriate infill areas.*
>
> *All CARL lands and any adjacent habitat areas will be closed to future development and purchased in an accelerated acquisition program In sparsely developed areas, any land within 1000 feet of the CARL/Habitat areas will also be designated for purchase.*
>
> *Infill will only be permitted on suitable parcels subdivisions, which are at least 50 percent developed. A maximum of 3,000 scarified lots in these subdivisions will be permitted in a lottery system over the next 20 years. Scattered lands within subdivisions that contain habitat or "redflag" wetlands will be purchased and a conservation easement placed on the lots to prevent future development. Ocean Reef and other subdivisions, which are vested will continue to build out on lots with habitat, but red flag wetland lots will not be filled and developed.*
>
> *In the Urban Residential District and the Suburban Commercial District in Key Largo/Tavernier, and from Stock Island to Big Coppit an additional 500 multi-family, affordable housing units will be developed on scarified lands at a density of 15 to 20 units per acre. Redevelopment of trailer parks and other substandard housing throughout the Keys will be at the existing density, above base flood, and with sanitary sewer.*
>
> *Twenty-five percent of the existing commercial stock will be redeveloped, resulting in improved stormwater management and landscaping. Infill sites for commercial development will be within 200 feet of existing commercially developed areas. A total of 700,000 square feet of commercial will be permitted over the next 20 years either in expansion of existing uses or in infill sites. Institutional uses will be deducted from the 700,000 square feet, although they will not have to compete for square footage.*
>
> *Fifty percent of the existing Industrial and Marine Industrial sites will be cleaned up and redevelop with stormwater management and landscaping. Future uses will be of a more light industrial nature. All County owned buildings would be landscaped and retrofitted for stormwater management.*

Two additional parks of 5-10 acres each will be developed in the lower Keys: one on Big Pine Key and one on Sugarloaf.

With full implementation of the Overseas Heritage Trail and the Scenic Highway program, the entire U.S. 1 alignment will be landscaped. The stormwater management plan will be implemented on State and County roadways and for all new development. The sewer master plan will be fully implemented with the removal of all cesspits. An active program of water conservation will be instituted for existing development, the building code will assure new development conserves water."

The scenario encompasses the entire study area with a timeframe of 20 years. Although this scenario encourages infill and some redevelopment, it was defined as a "new development" or additional growth scenario, rather than a redevelopment or restoration scenario. The smart growth scenario was input into CCIAM through a series of specific entries and choices in the Graphical User Interface (Table 11.1), the resulting land use map appears in Appendix G, Map 4.

11.3 Model Refinements Based on Test Results

11.3.1 Land Use and Socioeconomics

The initial test completed in November 2001 estimated a permanent population of 64,550, which is 19 percent lower than the 79,589 permanent population estimated in the Census 2000. The discrepancy was due to the fact that the number of housing units estimated from the parcel database was 37,947, significantly lower than the Census 2000 figure of 51,617. As discussed in Section 3, discrepancies between the parcel database's property codes and the observed land uses explained most of the difference between the CCIAM and 2000 Census values. The reconciliation between observed and coded land uses, as well as a spatial calibration of CCIAM data using Census 2000 GIS data resulted in a recalculation of housing units and population that is within 5 percent of the Census 2000 population. Therefore, potential ripple effects of underestimating housing units and population have been averted. Using the calibrated current conditions, the predicted permanent population in the smart growth scenario is 85,014 for an increase of 10.7 percent in 20 years.

The smart growth scenario provided for an additional 3,878 housing units over twenty years, an increase of 7.5 percent over the 51,616 housing units reported for 2000 by the U.S. Census. The largest increase occurs in Ocean Reef/PAED 21 (North Key Largo) (601 additional units), Plantation Key (471), Summerland Key (465), and PAED 16 (Rodriguez Key) (438). These four planning units account for 51 percent of all new residential development. This represents an increase of 805 acres of residential development (Table 11.2). Open space and recreational land use is the dominant land use in almost all of the planning units for both scenarios, accounting for approximately 57 percent of current conditions and 63 percent of smart growth total land area. This includes wetlands and all natural habitat areas.

TABLE 11.1
CCIAM GUI CHOICES FOR SMART GROWTH SCENARIO

Vacant Land

Keys-wide except Ocean Reef

- Change vacant land parcels proposed for conservation by CARL and adjacent (300 ft distance) habitat to "Open Space."
- Change sparsely developed (<25 percent) subdivision Vacant Land lots containing habitat polygons within 1,000 feet of CARL lands to Open Space.
- Change 3,000 scarified Vacant Land parcels, in moderately or densely developed (= 75 percent) subdivisions, with no wetland or habitat polygons to Residential at the existing density level of the subdivision. Apply default stormwater and wastewater treatment parameters.
- Change Vacant Land and/or Commercial land within 200 feet of existing Commercial land to Commercial, with existing zoning to produce 700,000 square feet of commercial GFA.

Ocean Reef (Ocean Reef/PAED 21 (North Key Largo) Planning Area):

- Change all vacant land parcels with "red flag" wetlands to open space.
- Change all other vacant land parcels to developed at the existing zoning and density for the area. Apply default stormwater treatment; apply existing wastewater treatment.

- Key Largo/Tavernier and Stock Island to Big Coppitt (PAED 15 (Tavernier), PAED 16 (Rodriguez Key), PAED 17 (Rock Harbor), PAED 18 (John Pennecamp State Park), PAED 19 and 20 (Garden Cove), PAED 21 (North Key Largo), Stock Island, and Boca Chica Planning Areas):

- Change scarified vacant land parcels zoned Urban Residential (UR) and Suburban Commercial (SC) to provide 500 multifamily units at a density of 15 units per acre (HDR classification). Apply default stormwater and wastewater treatment.

Redevelopment

Keys-Wide

- Query for Trailer Parks and "substandard lots" (residential, <5,000 ft^2 parcel, structure < 1,200 ft^2 and >25 years old); "Change From" existing residential density to same residential density, but apply base flood elevation and current zoning restriction. Apply default wastewater and stormwater treatment.
- Query for "blighted" commercial parcels (<19 percent FAR, structure assessed value < 33 percent of land value, structure < 1,200 ft2 and >20 years old); "Change From" existing commercial density, but apply default stormwater and wastewater treatment for 25 percent of the parcels.
- Query for "blighted" industrial/marine industrial parcels (<19 percent FAR, structure assessed value < 33 percent of land value, structure < 1,200 ft2 and >20 years old); Change from existing industrial to light industrial land use, and apply default stormwater and wastewater treatment for 50 percent of the parcels.

Retrofitting

- Apply default stormwater and wastewater treatment to all county-owned lands parcels.
- Query for all parcels with "cesspit" as wastewater treatment. Change wastewater treatment to default wastewater treatment.
- Apply default stormwater treatment default to all Road parcels on U.S. 1.

- Water Conservation

- Apply current building code water conservation defaults for parcels changed from Vacant Land to Residential, Commercial, or Industrial, and all redeveloped parcels.

TABLE 11.2
RESIDENTIAL LAND USE BY SCENARIO (ACRES)

Planning Unit	Current Conditions	Smart Growth	Difference
Bahia Honda/Ohio Key	34.8	34.8	0.0
Bay Point	41.4	46.8	5.4
Big Pine Key	687.5	720.7	33.2
Big/Mid Torch Key	146.0	147.3	1.3
Boca Chica	183.4	193.4	10.0
Cudjoe Key	273.0	299.0	26.0
Key West	791.1	800.0	8.9
Little Torch Key	153.6	155.1	1.5
Long Key/Layton	71.9	87.7	15.8
Lower Matecumbe	273.3	286.5	13.2
Lower Sugarloaf	310.8	327.8	17.0
Marathon Primary	972.1	1,065.4	93.3
Key Colony Beach	350.5	353.6	3.1
PAED 15 (Tavernier)	294.0	304.3	10.3
PAED 16 (Rodriguez Key)	259.6	315.5	55.9
PAED 17 (Rock Harbor)	386.8	435.2	48.4
PAED 18 (John Pennecamp State Park)	322.0	330.7	8.7
PAED 19 and 20 (Garden Cove)	271.0	285.9	14.9
Ocean Reef Club/PAED 21 (North Key Largo)	581.4	879.0	297.6
PAED 22 (Cross Key)	0.0	0.0	0.0
Plantation Key	645.9	706.5	60.6
Ramrod Key	112.5	112.5	0.0
Stock Island	251.5	255.4	3.9
Summerland Key	241.8	290.5	48.7
Upper Matecumbe	254.4	273.5	19.1
Upper Sugarloaf	179.7	188.0	8.3
Windley Key	17.2	17.2	0.0
Totals	8,106.9	8,912.2	805.3

Housing affordability was addressed only for the current conditions to provide a measure of the ability of residents to afford the costs of new housing in a community. The index is a ratio of the median income per household over the median price of new houses, adjusted for the debt ratio banks typically accept for mortgages. A value <1 for this index suggests that the median household in the planning unit is unable to afford a median-priced house in the same planning area. All but three planning units have index values of <1 (Table 11.3), suggesting that the median household income cannot afford the median house price throughout most of the Florida Keys.

TABLE 11.3
CURRENT HOUSING AFFORDABILITY IN THE FLORIDA KEYS

Planning Unit	Housing Affordability Index
Bahia Honda/Ohio Key	1.02
Bay Point	0.81
Big Pine Key	1.02
Big/Mid Torch Key	0.98
Boca Chica	0.85
Cudjoe Key	0.81
Key West	0.42
Little Torch Key	0.74
Long Key/Layton	0.74
Lower Matecumbe	0.53
Lower Sugarloaf	0.63
Marathon Primary	0.52
Key Colony Beach	0.57
PAED 15 (Tavernier)	0.64
PAED 16 (Rodriguez Key)	0.40
PAED 17 (Rock Harbor)	0.50
PAED 18 (John Pennecamp State Park)	1.03
PAED 19 and 20 (Garden Cove)	0.88
Ocean Reef Club/PAED 21 (North Key Largo)	0.43
PAED 22 (Cross Key)	0.39
Plantation Key	0.54
Ramrod Key	0.92
Stock Island	0.58
Summerland Key	0.55
Upper Matecumbe	0.46
Upper Sugarloaf	0.64
Windley Key	0.10

11.3.2 Fiscal Module

The test of the CCIAM in November 2001 determined that the Fiscal Module functioned properly and produced appropriate outputs. The Monroe County Capital Facilities Capacity Assessment Report (Monroe County 2001) indicates that the Monroe County School District currently has a space deficit of 100,000 square feet. In addition, the Sanitary Wastewater and Stormwater Master Plans provide for substantive investments to address wastewater and stormwater issues. The cost for these improvements is an unfunded liability, and is added to the current conditions expenditures. An adjusted per capita expenditure is calculated by dividing the total current and unfunded costs by the current functional population.

Unfunded liabilities are significant, primarily in the areas of school system capital facilities, and wastewater and stormwater treatment capital improvements and operating cost. Funding these needs will result in annual per capita governmental expenditures ranging from 8.49 percent to 15.85 percent higher than current conditions depending on planning unit. Overall, annual expenditures are projected to increase by 12.61 percent just to cover the unfunded liabilities (Table 11.4). Under smart growth, annual per capita expenditures increase an additional 8.4 percent.

TABLE 11.4
GOVERNMENT EXPENDITURES

	Current Conditions	Current Conditions Plus Unfunded Liabilities	Smart Growth (Including Current Unfunded Liabilities)
Total Annual Expenditure	$479,575,564	$540,035,031	$620,544,786
Annual Per Capita Expenditure	$3,240	$3,648	$3,952
Functional Population*	148,035	148,035	158,126

* The Fiscal Module uses functional population under the assumption that government expenditures cover the needs of all population similar to t he use of functional population to plan facilities expansion in Monroe County.

This estimate indicates a sharp increase in per capita government expenditures, which would obligate government to increase revenue. Revenue to cover the increased expenditure may be obtained in many ways, such as cost-sharing arrangements with state and federal agencies, bond issues, and tax increases.

11.3.3 Infrastructure

Traffic

The tests of the CCIAM in November demonstrated that the initial formulation of a trip generation model produced results that were in conflict with median speed observed under current conditions. The regression approach (Section 7) predicts changes in median speeds from 0 to –0.5 mph. Any reduction in median speed in Big Pine Key places the segment further below the required LOS. The range of variation (0 to –0.5) associated with the smart growth scenario is narrower than the recorded change from 2000 to 2001 (4.1 to -2.9 mph, MCPD 2001). Considering that the smart growth scenario would be implemented over 20 years, the predicted 20-year change is well within the range of annual fluctuation and, therefore, suggests no significant overall change in median speed and, therefore, LOS.

Hurricane Evacuation

Initial testing of the Miller Consulting model after coupling with the CCIAM shows that the CCIAM produces appropriate outputs, which, in turn, can be input into the hurricane model. Two test runs were conducted. The current conditions used the Census 2000 results for housing units and populations, whereas the smart growth used the projected housing units.

The Final Florida Keys Hurricane Evacuation Study Report (Miller Consulting, Inc. 2001) shows that the time required to evacuate the Keys up to Florida City is 24 hours 32 minutes for year 2000 conditions under a normal response curve for a Category 3-5 hurricane. Using 2000 Census data, the results are similar to those reported by Miller for (24:58:00 versus 24:32:00). Under the smart growth scenario, the clearance time increases by 1 hour and 18 minutes.

11.3.4 Integrated Water Module

Initial test results and subsequent refinements based on comments received regarding these tests, has shown that the Integrated Water Module allows meaningful comparisons among land development scenarios.

Potable Water Component

The total potable water demand was calculated for current conditions and smart growth scenarios. Calculations at the planning unit level use the total number of EDUs and the specific potable demand established for the planning unit. The individual and aggregate potable water demands, and corresponding pipeline conveyance requirements, are higher in the smart growth scenario than in current conditions scenario, and are used as the basis for discussion of impacts on water infrastructure. This component is yet to be re-calculated using Census 2000 calibrated data. Computer programming is in progress. Therefore, these results are not to be interpreted as absolute.

Total Demand. The projected annual average total demand of potable water was 14.95 MGD for current conditions. The projected annual average total demand for smart growth was 12 percent higher than current conditions. The largest increase occurred in Marathon Primary (84 percent), Key Colony Beach (51 percent), Bahia Honda Key (32 percent), and the Key Largo Area (Ocean Reef Club + PAED 21 (North Key Largo) + PAED 22 (Cross Key)) (22 percent). The projected cumulative maximum monthly average demand was estimated at 16.18 MGD, with the maximum day demand estimated at 19.41 MGD. This model is not intended to predict actual consumption, but to compare scenarios.

The average potable water demand under smart growth is lower than the currently permitted average capacity of 15.83 MGD. The projected maximum day pumping requirement slightly exceeds the wellfield's permitted capacity. The FKAA confirmed that the system's storage capacity is 42.4 MGD; therefore, the difference (0.22 MGD) should be readily handled by the existing storage capacity in the FKAA system. The anticipated growth in the smart growth scenario will essentially consume the remaining withdrawal capacity of the FKAA wellfield under maximum day conditions.

Water Treatment Plant Impacts. The 22 MGD capacity of FKAA's existing water treatment plant is sufficient to meet the projected potable water demands for smart growth for the average day, maximum month day, and maximum day conditions. The anticipated growth under smart growth will consume a significant portion of the residual capacity of the existing water treatment system under maximum day conditions. However, the FKAA's water plant expansion program, currently under construction, will increase treatment capacity to 25 MGD, which will provide additional treatment capacity and redundancy for the system.

Aqueduct Pipeline Impacts. Comparison of the projected average day demands against the reported capacity of the FKAA pipeline in each segment indicated that the existing pipeline is adequate to handle the smart growth scenario potable water conveyance. The projected cumulative maximum day flow in each of the planning units typically required less than 60 percent of the rated aqueduct segment capacity. The highest use of aqueduct capacity occurs at the northern end of the Keys, in the Key Largo Area (Ocean Reef Club + PAED 21 (North Key Largo) + PAED 22 (Cross Key)), where the potable water supply first enters the Study Area.

Wastewater Component

As part of testing the CCIAM, wastewater effluent pollutant loads were computed for both scenarios using the total number of EDUs and the effulent characteristics from EPA/DEP. Raw wastewater loads (before treatment) were higher under smart growth than current conditions due to projected growth. However, the total wastewater effluent loads were lower in smart growth, reflecting the effect of the elimination of cesspits and septic tanks in the hotspots and the upgrading of substandard wastewater treatment plants. The difference in loads appears lower than expected. Programming of the corrected land use layer's relationship with the wastewater component is being evaluated in order to check for potential inconsistencies.

TABLE 11.5
WASTEWATER EFFLUENT DISCHARGE LOADS FOR THE FLORIDA KEYS

Scenario	BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)
Current Conditions	3,145	3,125	2,834	278
Smart Growth	3,103	3,803	2,789	273
Net Change	-42	-42	-45	-5
Percent Change	-1%	-1%	-1%	-2%

On-Site Systems. There are a total of 40,228 EDUs served by on-site wastewater treatment systems in the study area under current conditions. Approximately half of the computed population occurs in five planning units: Marathon Primary, Plantation Key, PAED 17 (Rock Harbor), PAED 18 (John Pennecamp State Park), and PAED 19 and 20 (Garden Cove). The total number of EDUs served by onsite systems in the smart growth scenario was 55 percent lower than in current conditions. The CCIAM calculates loads from OSTDS using the effluent characteristics in Table 8.2. However, it is acknowledged that the actual efficiency of OSTDS may differ from those in Table 8.2 as well as across the Keys.

Existing WWTPs. Under current conditions, there are 19 substandard wastewater treatment plants, which are upgraded in the Smart Growth Scenario to either BAT or AWT treatment processes pursuant to the Sanitary Wastewater Master Plan. The current conditions scenario also includes three wastewater treatment plants that comply with current minimum treatment processes pursuant to the Sanitary Wastewater Master Plan, and they have been expanded.

New WWTPs. Elimination of hot spot onsite systems and projected growth in the smart growth scenario have resulted in the implementation of nine of the recommended BAT or AWT wastewater treatment plants pursuant to the *Sanitary Wastewater Master Plan*. The largest plant includes a 2.0 MGD Marathon Regional WWTP, a 2.0 MGD Tavernier/Key Largo Regional WWTP and a 1.7 MGD Islamorada Regional WWTP. The remaining new WWTPs have capacities of less than 0.5 MGD.

Treated Wastewater Effluent Discharges. Daily effluent discharges were projected for each wasteshed, aggregated to planning unit level, and then summarized for both scenarios. The projected daily effluent discharge to the active surficial region of the aquifer was 12.74 MGD under current conditions; this value is reduced to 9.51 MGD after consideration of deep well effluent disposal volumes. The net projected daily effluent discharge to the aquifer system for the smart growth scenario was 13.93 MGD, reduced after deep well discharges to 11.72 MGD. The most significant increases for the smart growth scenario occurred in four planning units: Marathon Primary, Key Colony Beach, Bahia Honda Key and the Key Largo Area (Ocean Reef Club + PAED 21 (North Key Largo) + PAED 22 (Cross Key)).

Stormwater Component

In order to test the CCIAM, stormwater flows and pollutant loads were computed for the current conditions and smart growth scenarios using the projected land uses, EMC values, and selected load reductions attributable to BMPs. The stormwater treatment strategies recommended in the Stormwater Management Master Plan were applied to new development and redevelopment at the parcel level, as well as the retrofitting strategies for identified problem areas. These loads were then aggregated to the watershed (sub-planning unit) level. Corresponding load reductions due to implementation of stormwater BMPs were computed, and the resulting runoff volumes and pollutant loads were summed for each scenario.

On-Site Stormwater Treatment. Very little onsite stormwater treatment has been documented in the study area. However, extensive use of BMPs is required under the smart growth strategies, which resulted in implementation of stormwater BMPs that serve 7,086 acres of the Florida Keys.

Stormwater Flows and Pollutant Loads. The benefits attributable to stormwater BMPs for reducing pollutant loads for BOD, TSS, TN, and TP were calculated for the Smart Growth Scenario at the aggregated planning unit level. The smart growth BMP benefits were compared to the smart growth scenario loads without BMPs to demonstrate the relative reductions that can be achieved through BMP implementation. The additional development in the smart growth scenario produced higher gross loads. However, the implementation of BMPs per the stormwater master plan results in load reductions of 16 to 21 percent (Table 11.6).

Comparison of Stormwater Loads. While limited studies of stormwater discharge characteristics and net pollutant loads have been developed in the Florida Keys, the CCIAM's Smart Growth Scenario results were compared to two studies which were published in the last decade: the WQPP report prepared by EPA for the Florida Keys (1992) and the Stormwater Management Master Plan. Considering that the CCIAM and the master plan use different methods, EMCs, and spatial coverage, the results of the two studies are remarkably similar.

TABLE 11.6
COMPARISON OF STORMWATER RUNOFF LOADS

Scenario	BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)
Gross Loads Generated				
Current Conditions	7,077	17,291	1,076	163
Smart Growth	7,617	18,497	1,138	171
Net Change	540	1,206	62	4
Percentage Change	8%	7%	6%	5%
BMP Benefit of Smart Growth Strategy				
Gross Load	7,617	18,497	1,076	171
Net Discharged Load	6,031	14,754	995	144
Net Change	-1,586	-3,743	-183	-27
Percentage Change	21%	20%	16%	16%

TABLE 11.7
COMPARISON OF STORMWATER LOAD PREDICTIONS

	Flow MGD	BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)
CCIAM Current Conditions	72.67	7,077	17,291	1,076	163
WQPP Report for the Florida Keys				1,000	89
Stormwater Management Master Plan	77.25	3,945	21,000	669	114

Groundwater Component

In order to test the model, groundwater flows and pollutant loads were computed for both scenarios using the inputs from the Stormwater and Wastewater Components (Table 11.8). The total post-treatment stormwater loads were lower in smart growth. The relative benefit of BMP implementation required under the smart growth strategies is shown in terms of the net reduction of pollutant loads entering the groundwater system.

TABLE 11.8
COMPARISON OF INPUTS TO THE GROUNDWATER SYSTEM

Scenario	BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)
Current Conditions	5,802	10,246	3,354	322
Smart Growth	5,604	9,770	3,293	316
Net Change	-198	-476	-61	-6
Percentage Change	-3%	-5%	-2%	-2%

11.3.5 Terrestrial Environment

Habitat Loss and Fragmentation

Since the 1800s, development in the Florida Keys has occurred primarily in upland areas, resulting in the loss of almost half of the upland habitats, from 20,038 acres in pre-development times to 10,353 acres in 1995. Along with habitat loss, upland habitats have been severely fragmented into numerous, smaller patches (Figures 11.1a and 11.1b). This is in sharp contrast with pre-colonial conditions, where the average patch size was over 100 acres.

FIGURE 11.1a
NUMBER OF UPLAND PATCHES IN THE FLORIDA KEYS, 1800 – 1995

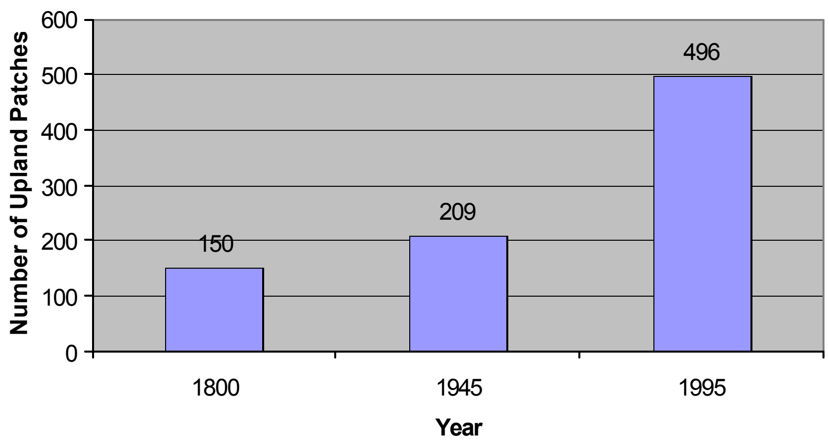
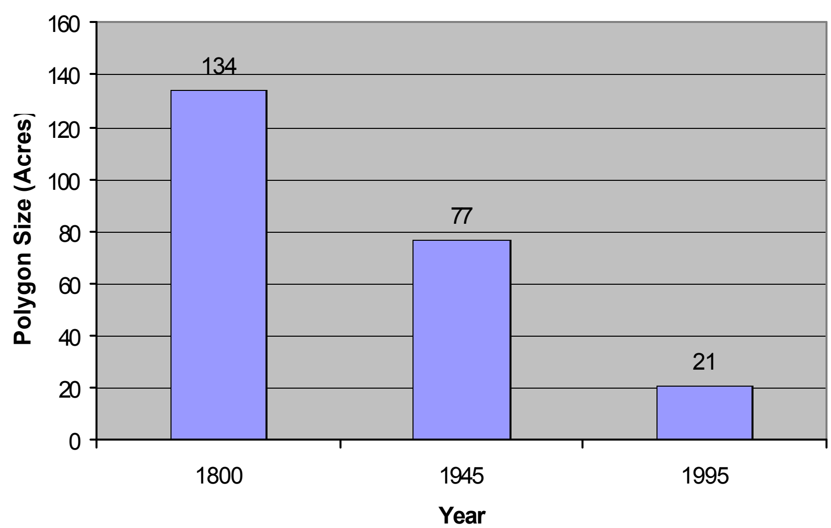


FIGURE 11.1 b
AVERAGE SIZE OF UPLAND PATCHES IN THE FLORIDA KEYS, 1800 – 1995



Tests of the CCIAM showed that under both current conditions and smart growth, approximately 80 percent of all upland habitat patches are less than five acres (Figure 11.2). The frequency of small patches is lowest in the Lower Keys and highest in the Upper Keys. Keys hammocks smaller than 13 acres are considered "all edge," with forest interiors lacking the buffering effects of edge vegetation (Strong and Bancroft 1994).

FIGURE 11.2 a
DISTRIBUTION OF UPLAND PATCH SIZES IN THE FLORIDA KEYS – CURRENT CONDITIONS

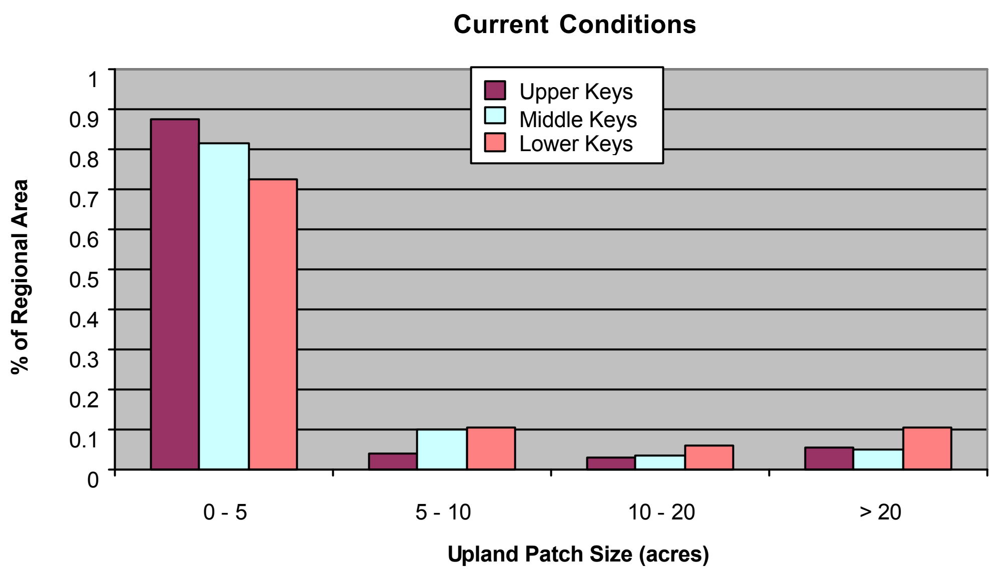
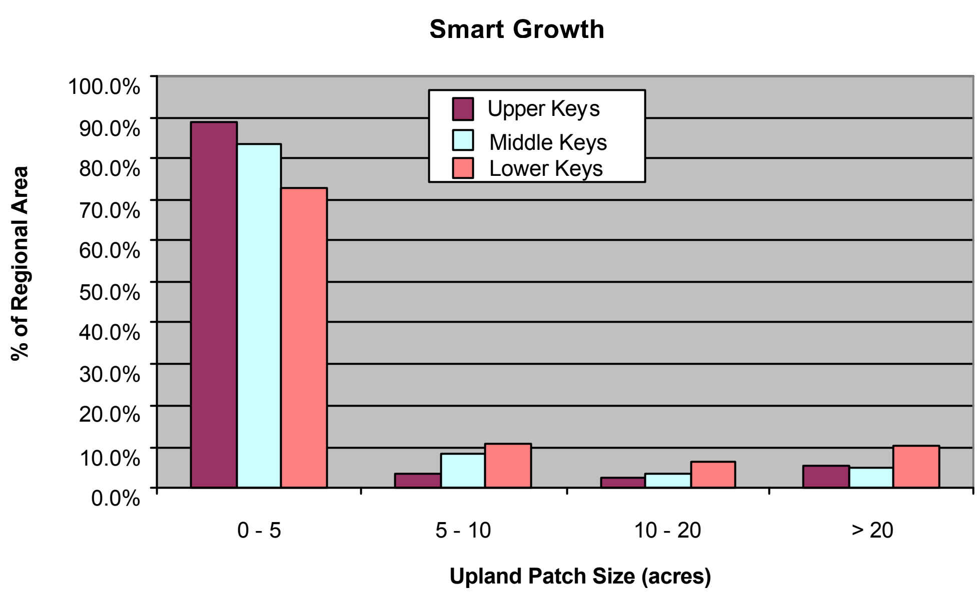


FIGURE 11.2 b
DISTRIBUTION OF UPLAND PATCH SIZES IN THE FLORIDA KEYS – SMART GROWTH



Species Richness

Species richness, here approximated by the potential occurrence of up to 17 species of concern in 30 x 30 foot cells, is highest in the Lower Keys and lowest in the Middle Keys (see examples in Figures 11.3 and 11.4). The overlay analysis results in a maximum of 10 species per cell in the richest areas. Throughout the Florida Keys, low species richness cells account for the majority of the area. Because smart growth focuses development on infill areas, additional habitat loss and direct effects on species richness is small (Table 11.9).

FIGURE 11.3
SPECIES RICHNESS IN THE FLORIDA KEYS – HIGH SPECIES RICHNESS AREA

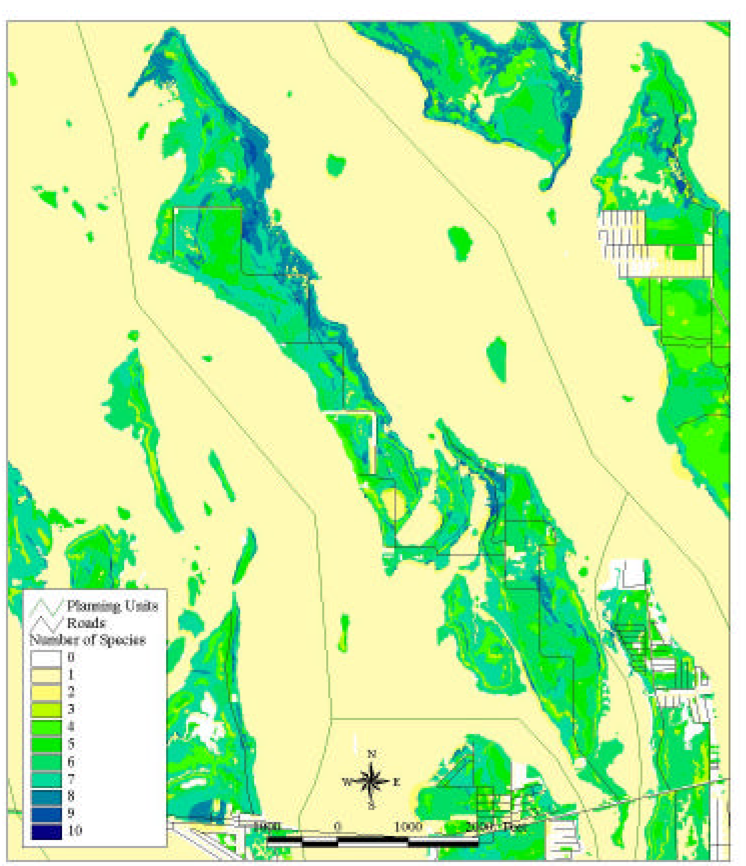


FIGURE 11.4
SPECIES RICHNESS IN THE FLORIDA KEYS – LOW SPECIES RICHNESS AREA

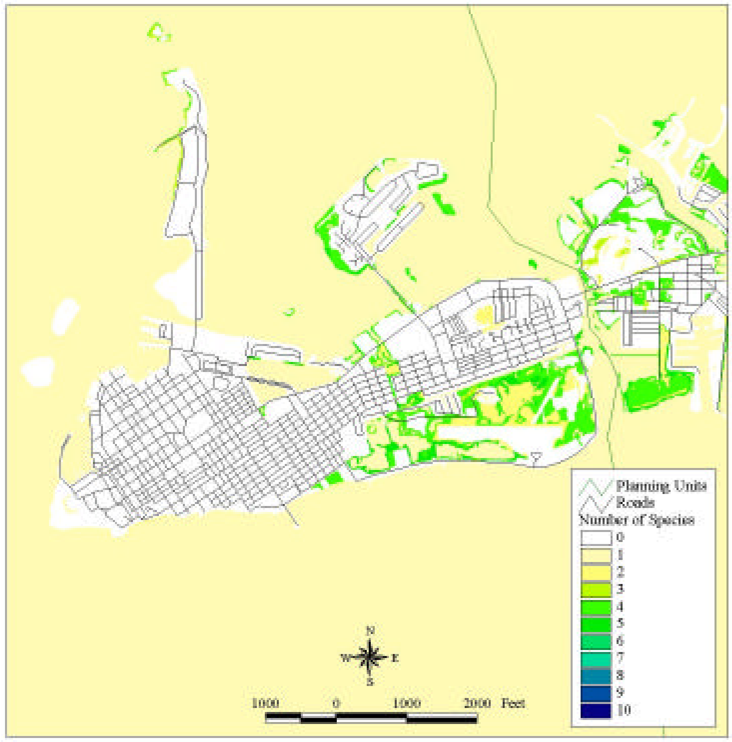


TABLE 11.9
DIRECT IMPACTS – CHANGE IN SPECIES RICHNESS INDEX

	Current Conditions	Smart Growth	Difference
Ocean Reef Club	2.2	2.0	-0.2
PAED 21 (North Key Largo)	5.1	5.0	-0.1
PAED 22 (Cross Key)	3.5	3.5	0.0
PAED 19 and 20 (Garden Cove)	3.0	3.0	0.0
PAED 18 (John Pennecamp State Park)	2.7	2.6	-0.1
PAED 17 (Rock Harbor)	1.5	1.5	0.0
PAED 16 (Rodriguez Key)	2.2	2.1	-0.1
PAED 15 (Tavernier)	2.3	2.3	0.0
Plantation Key	1.4	1.4	0.0
Windley Key	2.4	2.4	0.0
Upper Matecumbe	1.5	1.4	-0.1
Lower Matecumbe	2.2	2.2	0.0
Long Key/Layton	3.1	3.0	0.1
Key Colony Beach	2.0	2.0	0.0
Marathon Primary	1.3	1.3	0.0
Bahia Honda Key	3.6	3.6	0.0
Big Pine Key	4.2	4.2	0.0
Big/Mid Torch Key	5.7	5.7	0.0
Summerland Key	4.8	4.8	0.0
Cudjoe Key	4.1	4.1	0.0
Upper Sugarloaf	4.8	4.8	0.0
Lower Sugarloaf	4.2	4.2	0.0
Bay Point	4.7	4.7	0.0
Boca Chica	1.5	1.5	0.0
Stock Island	0.8	0.7	-0.1
Key West	0.4	0.4	0.0
Little Torch Key	3.4	3.4	0.0
Ramrod Key	3.7	3.7	0.0

Species-Specific Impacts

The smart growth scenario includes little encroachment into undeveloped habitat; therefore, overall additional impacts on species are also small. Additional impacts on Key deer are limited to the loss of low-quality habitat in Big Pine Key (200 residential lots in Tier 3 lands over 20 years). Therefore, the smart growth scenario does not jeopardize the species. Additional development under smart growth results in minor encroachment into Lower Keys marsh rabbit and silver rice rat habitat (Figures 11.5 and 11.6), suggesting that carrying capacity indicators for these species are surpassed. Besides direct loss of hammock areas within Ocean Reef (in North Key Largo), where vested developments may affect habitat, no additional impacts occur for the Key Largo woodrat and Schaus swallowtail butterfly under the smart growth scenario.

FIGURE 11.5
EXAMPLE OF SMART GROWTH DEVELOPMENT ON THE LOWER KEYS MARSH RABBIT

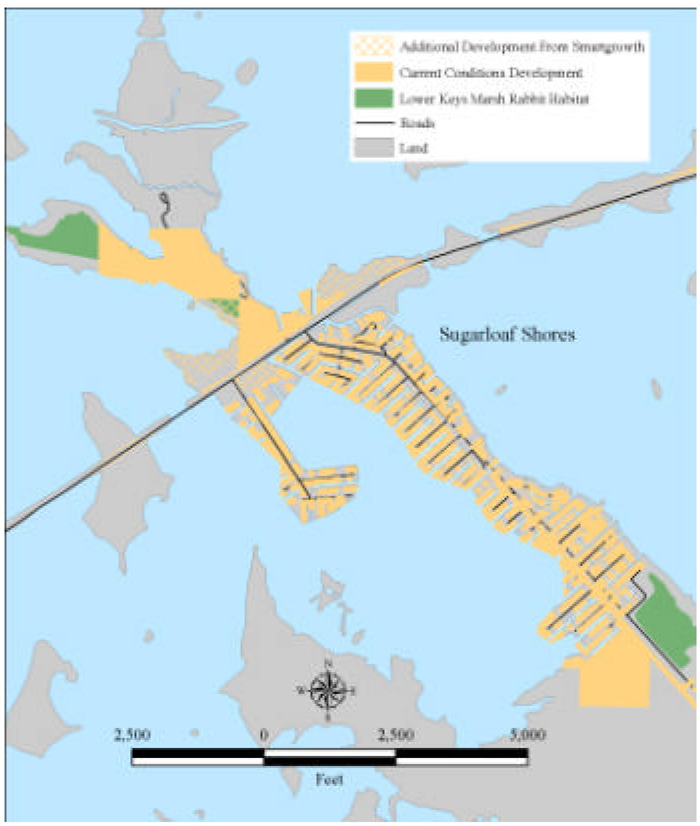
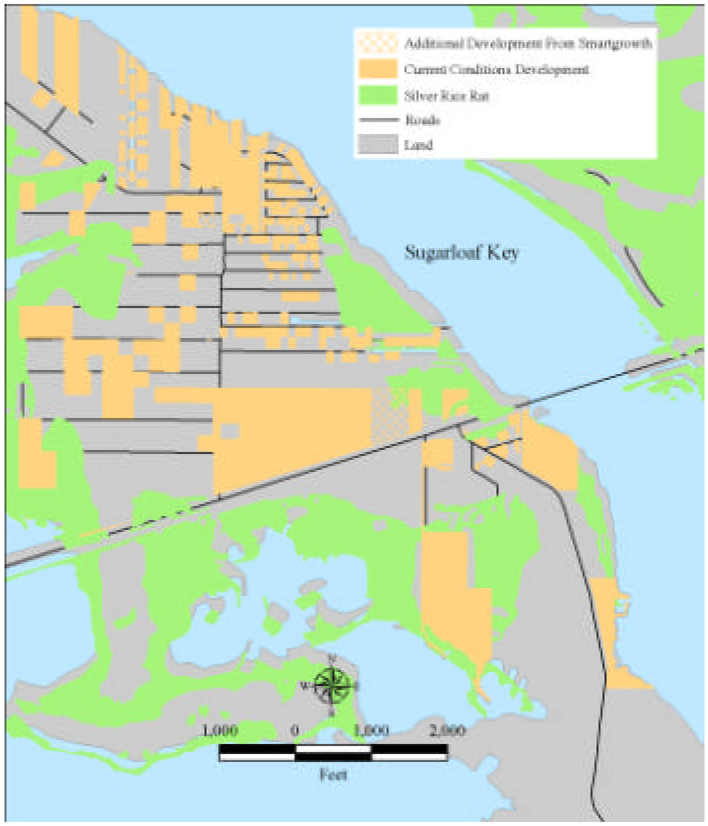


FIGURE 11.6
EXAMPLE OF SMART GROWTH DEVELOPMENT ON THE SILVER RICE RAT



For the white-crowned pigeon, the smart growth scenario results in habitat loss for both immature (2.1 percent loss) and mature pigeons (6.5 percent loss). Habitat loss was primarily due to fragmentation of habitat patches, which rendered patches too small to be used by pigeons (Figure 11.7).

The smart growth scenario also results in further fragmentation of forest-nesting birds' habitat, evidenced by in an increase in the number of polygons and a decrease in the total acreage available to the species (Table 11.10).

The smart growth scenario results in small additional habitat effects on the 11 species. However, the historical loss and fragmentation of upland habitat has already affected Florida Keys species to the point that many are listed as threatened and endangered. Further habitat impacts only exacerbate an already perilous situation and further endanger these species.

FIGURE 11.7
EXAMPLE – WHITE CROWNED PIGEON HABITAT LOSS UNDER SMART GROWTH

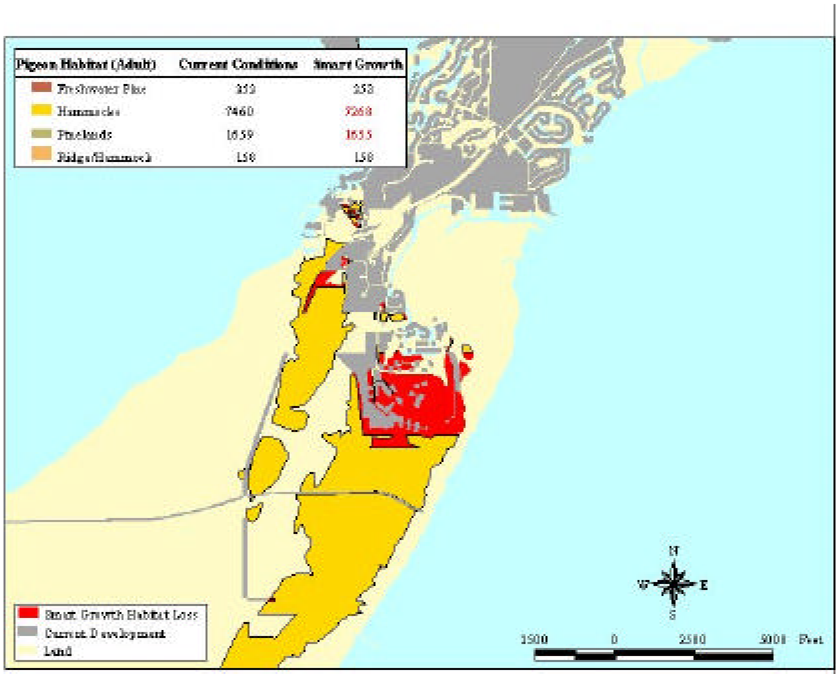


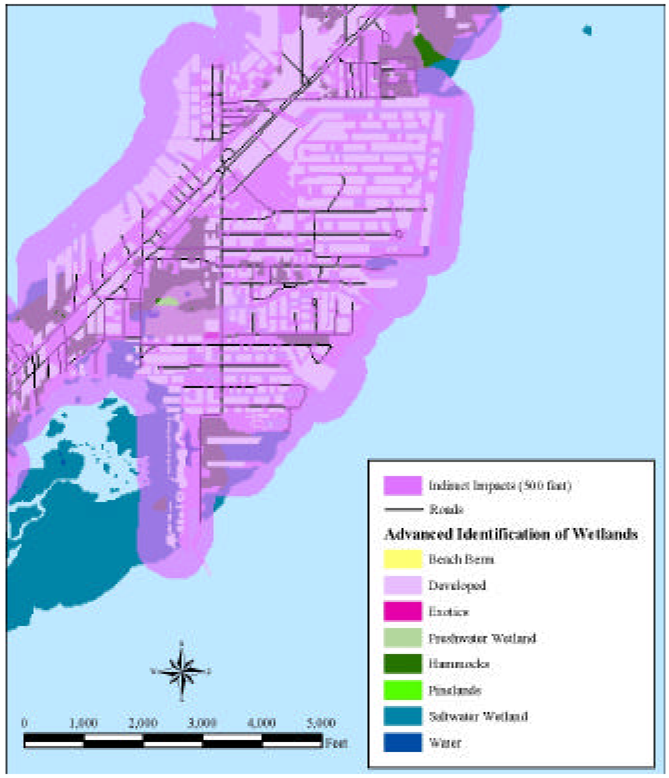
TABLE 11.10
RESULTS OF THE DIRECT IMPACTS TO FOREST INTERIOR BIRD HABITAT

Species	Current Conditions		Smart Growth	
	Habitat Acreage	**Number of Patches**	**Habitat Acreage**	**Number of Patches**
Black-eyed Vireo	3,019.19	1,023	2,692.52	1,300
White-eyed Vireo	2,456.61	177	1,980.54	303
Northern Flicker	2,320.63	130	1,693.41	202
Yellow Cuckoo	1,975.69	64	1,098.91	82
Mangrove Cuckoo	1,773.18	44	552.11	25

Secondary Impacts

The secondary effects of development on habitats, such as increased predation pressure due to the introduction of domestic predators, or the effects of increased and sustained noise levels, ripple through the habitat and may affect entire patches of native vegetation. Small patches, which are the rule in the Florida Keys, are often surrounded by development and may receive secondary effects around its entire perimeter. While difficult to quantify, secondary effects are likely to be more significant as patch size decreases. In many areas of the Florida Keys, particularly in the narrower Upper and Middle Keys, indirect effects cover entire patches of habitat (Figure 11.8).

FIGURE 11.8
INDIRECT EFFECTS



Sea Level Rise

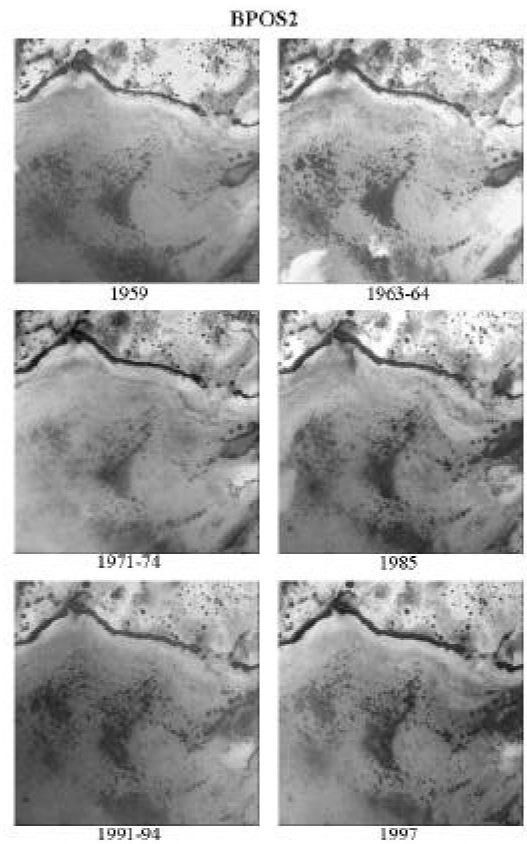
The FKCCS' planning horizon is 20 years. For Florida, the sea level is likely to rise 18 to 20 inches by 2100 (EPA website) or up to 3 to 4 inches in the next 20 years. No direct modeling of a 4-inch rise in sea level was possible, mainly because the topographic data for the Keys provides only 5-foot contours. However, as sea level rises, coastal areas in the Florida Keys may experience marine water encroachment into low-elevation areas, detectable saltwater intrusion into freshwater lenses, and habitat effects (e.g., Ross et al. 1994). In the long-term, sea level rise will impose additional constraints to development in the Florida Keys.

11.3.6 Marine Environment

While not built into the CCIAM, the Florida International University (FIU) investigation of nearshore benthic communities of the Florida Keys provided further insight into the potential effects of land development on the nearshore waters of the FKNMS.

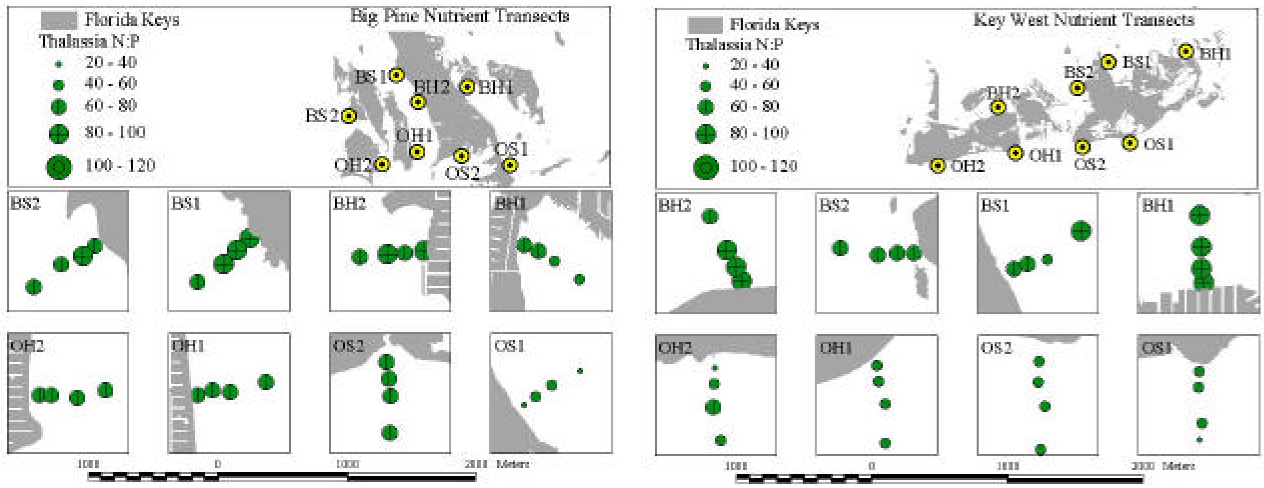
FIU's time series analyses of the black and white FDOT aerial photographs reveals very little change in the distribution of nearshore benthic communities in the Florida Keys since 1959 (Figure 11.9). There are no significant differences in the amount of keys-wide benthic macrophyte cover with respect to time (1959-1997, six time steps), location (oceanside or bayside), or land use (heavily or slightly developed). However, there are clear differences in the magnitude and direction of the minimal changes detected with respect to study area. The mean temporal change at most Key Largo and Marathon sampling sites were positive, reflecting small net increases, while the mean temporal change at most Big Pine and Key West sampling sites were negative, reflecting slight net decreases.

FIGURE 11.9
EXAMPLE TIME SERIES



Preliminary analyses of *Thalassia testudinum*, sediment, and epiphyte samples collected at 32 transects did not reveal any significant keys-wide trends in nutrient parameters with respect to location (oceanside or bayside), distance from shore (50 m, 100 m, 250 m, or 500 m), or land use (heavily or slightly developed). However, maps of nutrient data revealed potential significant relationships may exist within study areas (Figure 11.10). Further spatial analyses showed no conclusive relationships. N:P were high in the vast majority of samples, corroborating other reports of a P-limited environment.

FIGURE 11.10
THALASSIA N:P RATIOS IN BIG PINE KEY AND KEY WEST



11.3.7 Quality of Life

Test results of the CCIAM can be contrasted with the ranking of quality of life issues identified through the PIIP. The mean ranks were divided by the smallest rank and values were grouped in categories from 1 to 3.5 (Table 11.11). Water quality and conservation of habitat obtained the highest rank. Water quality would tend to improve with the implementation of the stormwater and wastewater master plans, as entered in the smart growth scenario. The smart growth scenario also includes the acquisition of CARL lands for conservation, thereby providing for increased conservation. The smart growth scenario also points to the increase in per capita government expenditures associated with implementing the master plans and completing land acquisition.

The smart growth scenario, as described by the local planners (Section 11.2.2), aims at a slow growth, focused on infill. It explicitly tries to maintain the current community character. The scenario results in a modest increase in traffic. Traffic is likely to increase even in the absence of further development, as south Florida visitors continue to be attracted by the Keys resources.

Other issues brought up by the community are not explicitly evaluated in the model. The study and the CCIAM provide results that allow for an assessment of the highest ranked issues.

TABLE 11.11
NORMALIZED RESULTS FROM THE COMMUNITY CHARACTER/ QUALITY OF LIFE ISSUES RANKING

Rank	Parameter	Relative Rank
1	Water Quality Protection/Improvement	1.0
2	Conservation of Existing Habitat	1.0
3	Maintain Current Community Character	1.5
4	Decrease Level of Traffic	1.5
5	More Land Use and Development Growth Controls	2.0
6	Affordable Housing	2.0
7	Improve Safety on U.S. 1	2.0
8	Strengthen Enforcement of Existing Government Regulations	2.0
9	Protection of Property Owner's Rights	2.0
10	Decrease Level of Tourism	2.0
11	Current Land Use and Development Growth Controls	2.5
12	Land Recreation Opportunities	2.5
13	Water Recreation Opportunities	2.5
14	Current Level of Tourism	2.5
15	Reduce Government Regulation	3.0
16	Less Land Use and Development Growth Controls	3.0
17	Increase Level of Tourism	3.5