

**Table of Contents**

<u>Section</u>		<u>Page</u>
1.0	INTRODUCTION .....	1
1.1	Objectives and Organization of the Report.....	1
1.2	Background and Legal Mandate .....	2
1.3	Development of the Florida Keys Carrying Capacity Study Scope of Work .....	3
1.4	User Needs Assessment .....	4
1.5	Technical Review and Public Input .....	5
1.5.1	Technical Review.....	5
1.5.2	Public Input.....	6
1.6	Scope of the Study and Stakeholders Expectations .....	7
1.6.1	Scope of the Study .....	7
1.6.2	Stakeholders Expectations .....	8
1.6.3	Other Similar Models.....	9
2.0	CARRYING CAPACITY/IMPACT ASSESSMENT MODEL OVERVIEW .....	11
2.1	Study Area: The Florida Keys Context.....	11
2.2	Key Concepts and Processes of the Carrying Capacity/ Impact Assessment Model .....	12
2.2.1	Key Concepts .....	12
2.2.2	Key Processes .....	14
2.3	Carrying Capacity/Impact Assessment Model Function .....	15
2.3.1	Scenario Generator .....	15
2.3.2	Analysis Modules.....	15
2.3.3	Carrying Capacity Indicators .....	17
2.4	Spatial Databases Used in the Study.....	18
2.5	Information Technology .....	19
3.0	LAND USE DATA FOR THE FLORIDA KEYS .....	21
4.0	SCENARIO GENERATOR .....	27
4.1	Graphical User Interface .....	27
4.2	Basis for Land Use Change in the Scenario Generator.....	32
4.3	Assumptions and Uncertainties.....	36
5.0	SOCIOECONOMIC MODULE .....	37
5.1	Technical Basis: Data Sources, Current Conditions, and Trends .....	37
5.1.1	Population and Housing .....	37
5.1.2	Employment and Income .....	40
5.1.3	Tourism.....	41
5.2	Module Structure .....	43

**Table of Contents  
(Continued)**

<u>Section</u>		<u>Page</u>
5.3	Calibration.....	45
5.3.1	Demographic Coefficients .....	46
5.3.2	Land Use Coefficients.....	46
5.3.3	Economic Coefficients.....	46
5.3.4	Financial Coefficients .....	46
5.4	Assumptions and Uncertainty.....	47
5.5	Example Module Calculations .....	48
5.6	Public Involvement and Information Program .....	49
5.6.1	Introduction.....	49
5.6.2	Research.....	49
5.6.3	Media Program.....	49
5.6.4	Meetings and Workshops.....	50
5.6.5	Stakeholder Relations .....	50
5.6.6	Public Information, Education, and Awareness.....	50
6.0	FISCAL MODULE.....	52
6.1	Overview .....	52
6.2	Module Structure .....	53
6.3	Per Capita Governmental Expenditures .....	55
6.4	Per Capita Governmental Expenditures Adjusted for Unfunded Liabilities .....	57
6.5	Allocation of Expenditures by Planning Area .....	57
7.0	HUMAN INFRASTRUCTURE MODULE .....	58
7.1	Overview .....	58
7.2	Traffic Component .....	58
7.2.1	Trip Generation Approach.....	58
7.2.2	Regression Approach.....	60
7.3.2	Residential Capacity .....	62
7.3	Hurricane Evacuation.....	62
8.0	INTEGRATED WATER MODULE.....	65
8.1	Overview .....	65
8.2	Data Collection and Investigation.....	65
8.3	Assumptions and Module Components .....	68
8.3.1	Weather Component .....	72
8.3.2	Potable Water Component .....	73
8.3.3	Stormwater Component .....	74
8.3.4	Wastewater Component .....	77
8.3.5	Groundwater Component .....	80

**Table of Contents  
(Continued)**

<u>Section</u>		<u>Page</u>
9.0	TERRESTRIAL MODULE.....	84
9.1	Overview .....	84
9.2	Spatial Data .....	84
	9.2.1 Base Data .....	84
	9.2.2 Historic Vegetation Map .....	85
	9.2.3 Species Richness Map .....	86
9.3	Habitat and Species-Specific Data Gathered During Literature Review .....	87
	9.3.1 Key Deer Population Viability Analysis.....	90
	9.3.2 Lower Keys Marsh Rabbit Population Biology and Viability.....	95
	9.3.3 Silver Rice Rat .....	97
	9.3.4 Key Largo Woodrat .....	98
	9.3.5 Schaus Swallowtail Butterfly.....	99
	9.3.6 Other Species Directly Addressed in the CCIAM .....	99
9.4	Module Components .....	99
	9.4.1 Direct Impacts.....	100
	9.4.2 Indirect Impacts.....	103
10.0	MARINE ECOSYSTEMS AND SPECIES.....	107
10.1	Overview .....	107
10.2	Water Quality and Benthic Communities of the Florida Keys National Marine Sanctuary .....	107
	10.2.1 General Characteristics of Water Quality in the Florida Keys National Marine Sanctuary .....	107
	10.2.2 Water Circulation.....	108
	10.2.3 Pathogens in the Marine Environment.....	108
	10.2.4 Effects of Nutrients on Benthic Communities .....	109
	10.2.5 Field Survey to Investigate Benthic Variations in the Nearshore Environment .....	112
	10.2.6 Pollutant Dispersal Approach .....	114
10.3	Direct Human Impacts on Marine Resources .....	115
	10.3.1 Propeller Scarring in Seagrasses and Boat Groundings on Coral Reefs.....	115
	10.3.2 Snorkeling and Diving Impacts on Coral.....	117
	10.3.3 Recreational Fishing .....	118
11.0	MODEL TESTING, RESULTS, AND REFINEMENTS .....	127
11.1	Overview .....	127
11.2	Selection of Test Scenarios.....	127
	11.2.1 Current Conditions Scenario .....	127
	11.2.2 “Smart Growth” Scenario .....	128

**Table of Contents  
(Continued)**

<u>Section</u>		<u>Page</u>
11.3	Model Refinements Based on Test Results .....	129
11.3.1	Land Use and Socioeconomics .....	129
11.3.2	Fiscal Module.....	132
11.3.3	Infrastructure .....	133
11.3.4	Integrated Water Module .....	134
11.3.5	Terrestrial Environment .....	138
11.3.6	Marine Environment .....	146
11.3.7	Quality of Life.....	148
12.0	CONCLUSIONS.....	151
12.1	Suitability of the Florida Keys Carrying Capacity Analysis Model.....	151
12.2	Preliminary Carrying Capacity Assessment .....	151
13.0	LITERATURE CITED .....	153
13.1	Other Literature: Reviewed but not Cited.....	164
	Appendix A: Delivery Order Reports .....	169
	Appendix B: Summary of Comments from Government Agencies and Non-Governmental Organizations for the Florida Keys Carrying Capacity Study.....	170
	Appendix C: Formulas.....	179
	Appendix D: Public Information and Involvement Plan Prepared by the Market Share Company .....	199
	Appendix E: Glossary .....	214
	Appendix F: List of Acronyms .....	230
	Appendix G: Maps.....	237

**List of Figures**

<b><u>Figure</u></b>		<b><u>Page</u></b>
2.1	Study Area.....	11
2.2	Carrying Capacity/Impact Assessment Model Process .....	14
3.1	Example FLUCCS Land Use Data in the Florida Keys .....	21
3.2	Example Land Use from the Parcel Dataset .....	22
3.3	Parcels Prior to Manual Correction.....	23
3.4	Parcels After Manual Correction Spatial Shift. ....	24
3.5	Land Use and Property Code Discrepancy.....	26
4.1	Scenario Selection.....	28
4.2	New Scenario Description .....	28
4.3a	Vacant Land Change from GUI Screens .....	29
4.3b	Vacant Land Change from GUI Screens .....	29
4.4a	Residential Change to GUI Screens.....	30
4.4b	Residential Change to GUI Screens.....	30
4.5	Restoration GUI Screen.....	31
4.6	Retrofitting GUI Screen.....	31
5.1	Trends of Resident and Temporary Population .....	38
5.2	Age Composition, 1990 and 1996 .....	38
5.3	Monroe County Housing Construction Trends .....	39
5.4	Average New Home Prices in Monroe County .....	39
5.5	Price Per Square Foot of a New Home .....	40
5.6	Trends of Personal Income Composition.....	41
7.1	Relationship Between Land Use and Median Speed on U.S. 1 .....	60
8.1	Relationship Between the Integrated Water Module and Other Carrying Capacity Analysis Model Modules.....	68
8.2	Relationship Between the Five Components of the Integrated Water Module. ....	71
9.1	Apparent Habitat within ADID Developed Polygons .....	85
9.2	Six Grid Layers Used to Generate Weighting Factor Grid for the Key Deer PVA .....	91
9.3	Key Deer PVA Model Grid Layers – For Any Given Scenario, the Location and Intensity of Development Affect Both the Carrying Capacity (Carrying Capacity Grid) and the Mortality (Harvest Grid) of the Key Deer .....	92
9.4	Key Deer Population Viability Analysis: Potential Effect of Development on the Key Deer Population.....	93
9.5	Key Deer Population Viability Analysis: Effect of Development on the Level of Take of Key Deer. ....	95
9.6	Lower Keys Marsh Rabbit Habitat .....	96

**List of Figures  
(Continued)**

<u>Figure</u>		<u>Page</u>
9.7	Silver Rice Rat Habitat .....	97
9.8	Land Ownership in Key Largo .....	98
9.9	Habitat Suitability for Key Deer. ....	102
10.1	Example of Benthic Communities GIS Layer from FMRI.....	111
10.2	Benthic Sampling Locations Near Marathon.....	113
10.3	Propeller Scars Mapped in the Upper Matecumbe Area.....	116
10.4	FMRI Boat Groundings Data in the Upper Keys.....	117
10.5	Nearshore and Offshore Catch (Number of Fish Caught Over Time) .....	121
10.6	Mean Length of Harvest (MM) - Nearshore and Offshore Species.....	122
10.7	Recreational Fishing Participation and Effort.....	123
10.8	Lobster Season and Mini-Season Catch and Participation .....	124
10.9	Catch Per Unit Effort (Number of Fish Caught Per Trip) By Species Over Time (NMFS MRFSS Data) .....	125
11.1a	Number of Upland Patches in the Florida Keys, 1800-1995 .....	138
11.1b	Average Size of Upland Patches in the Florida Keys, 1800-1995 .....	138
11.2a	Distribution of Upland Patch Sizes in the Florida Keys – Current Conditions. ....	139
11.2b	Distribution of Upland Patch Sizes in the Florida Keys – Smart Growth. ....	139
11.3	Species Richness in the Florida Keys – High Species Richness Area.....	140
11.4	Species Richness in the Florida Keys – Low Species Richness Area .....	141
11.5	Example of Smart Growth Development on the Lower Keys Marsh Rabbit .....	143
11.6	Example of Smart Growth Development on the Silver Rice Rat .....	144
11.7	Example – White Crowned Pigeon Habitat Loss Under Smart Growth. ....	145
11.8	Indirect Effects .....	146
11.9	Example Time Series .....	147
11.10	<i>Thalassia</i> N:P Ratios in Big Pine Key and Key West. ....	148

**List of Tables**

<b><u>Table</u></b>		<b><u>Page</u></b>
2.1	FKCCS Planning Units .....	13
2.2	CCIAM Analysis Modules and Components .....	15
2.3	Carrying Capacity Indicators for the FKCCS.....	15
3.1	PC Codes Utilization to Define Land Use Categories for the FKCCS.....	25
4.1	Specific Criteria of Suitability Ranking for Residential Land .....	34
4.2	Specific Criteria of Suitability Ranking for Nonresidential Land .....	35
5.1	Visitors to the Florida Keys 1995-1996.....	42
5.2	Average Visitor Expenditures by Person Per Day.....	42
5.3	Tourist-Related Businesses in Monroe County .....	43
5.4	Representative Input Data for Socioeconomic Module.....	44
5.5	Population Resulting from Hypothetical Scenario. ....	48
5.6	Population Required to Support Retail Area Created by Hypothetical Scenario. ....	48
5.7	Employment Required and Payroll Generated by Retail Area Created in Hypothetical Scenario. ....	48
5.8	Results from the Community Character/Quality Of Life Issues Ranking .....	51
6.1	Fiscal Module Components. ....	53
6.2	Government Expenditure Categories.....	56
7.1	Level of Service Criteria for Overall Speeds on U.S. 1 in Monroe County. ....	59
7.2	Roadway Capacity Per Type of Road. ....	59
7.3	Median Speed on U.S. 1 and Selected Land Uses in the Florida Keys .....	61
8.1	Components and Elements of the Integrated Water Module. ....	71
8.2	Effluent Characteristics by Treatment Method, Per FDEP and EPA .....	78
9.1	Species Included in the Species Richness Map. ....	87
9.2	Species-Specific Requirements and Limiting Factors for Selected Terrestrial Species .....	88
9.3	Key Deer Population Viability Analysis: Potential Effect of Development on the Key Deer Population. ....	94
9.4	Terrestrial Module Components and Elements.....	100
9.5	White-Crowned Pigeon Habitat Requirements.....	103
9.6	Hammock Patch Size Requirements for Forest Interior Birds.....	103
9.7	Effects of Development on Adjacent Habitats.....	104

**List of Tables  
(Continued)**

<b><u>Table</u></b>		<b><u>Page</u></b>
10.1	Programs that Address Pathogens in the Marine Environment in The Florida Keys.....	110
10.2	FKNMS Benthic Habitat Types .....	111
10.3	Types of Data by the MRFSS Survey Methods .....	119
11.1	CCIAM GUI Choices for Smart Growth Scenario .....	130
11.2	Residential Land Use by Scenario (Acres) .....	131
11.3	Current Housing Affordability in the Florida Keys .....	132
11.4	Government Expenditures.....	133
11.5	Wastewater Effluent Discharge Loads for the Florida Keys .....	135
11.6	Comparison of Stormwater Runoff Loads .....	137
11.7	Comparison of Stormwater Load Predictions .....	137
11.8	Comparison of Inputs to the Groundwater System.....	137
11.9	Direct Impacts – Change in Species Richness Index.....	142
11.10	Results of the Direct Impacts to Forest Interior Bird Habitat.....	145
11.11	Normalized Results from the Community Character/ Quality of Life Issues Ranking .....	149