Economic Benefits Provided by the Conservation of Natural and Agricultural Lands:

Southwest Florida case study

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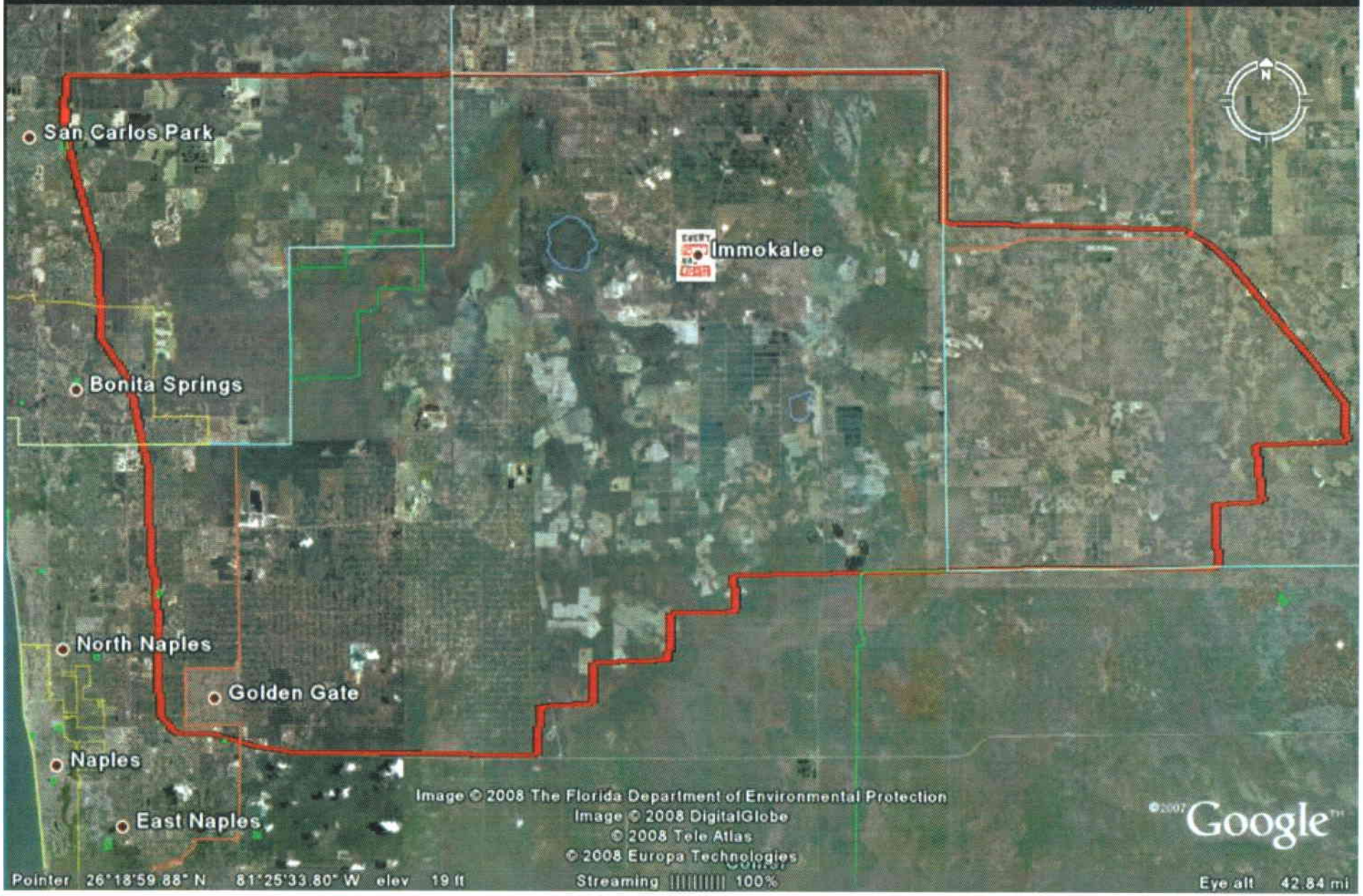
Background

- Part of a larger project: Identify and quantify the economic benefits provided by natural lands
- 5 case studies
  - Florida
  - Maine
  - Nebraska
  - New Mexico
  - Oregon
- Funded by the Doris Duke Charitable Foundation

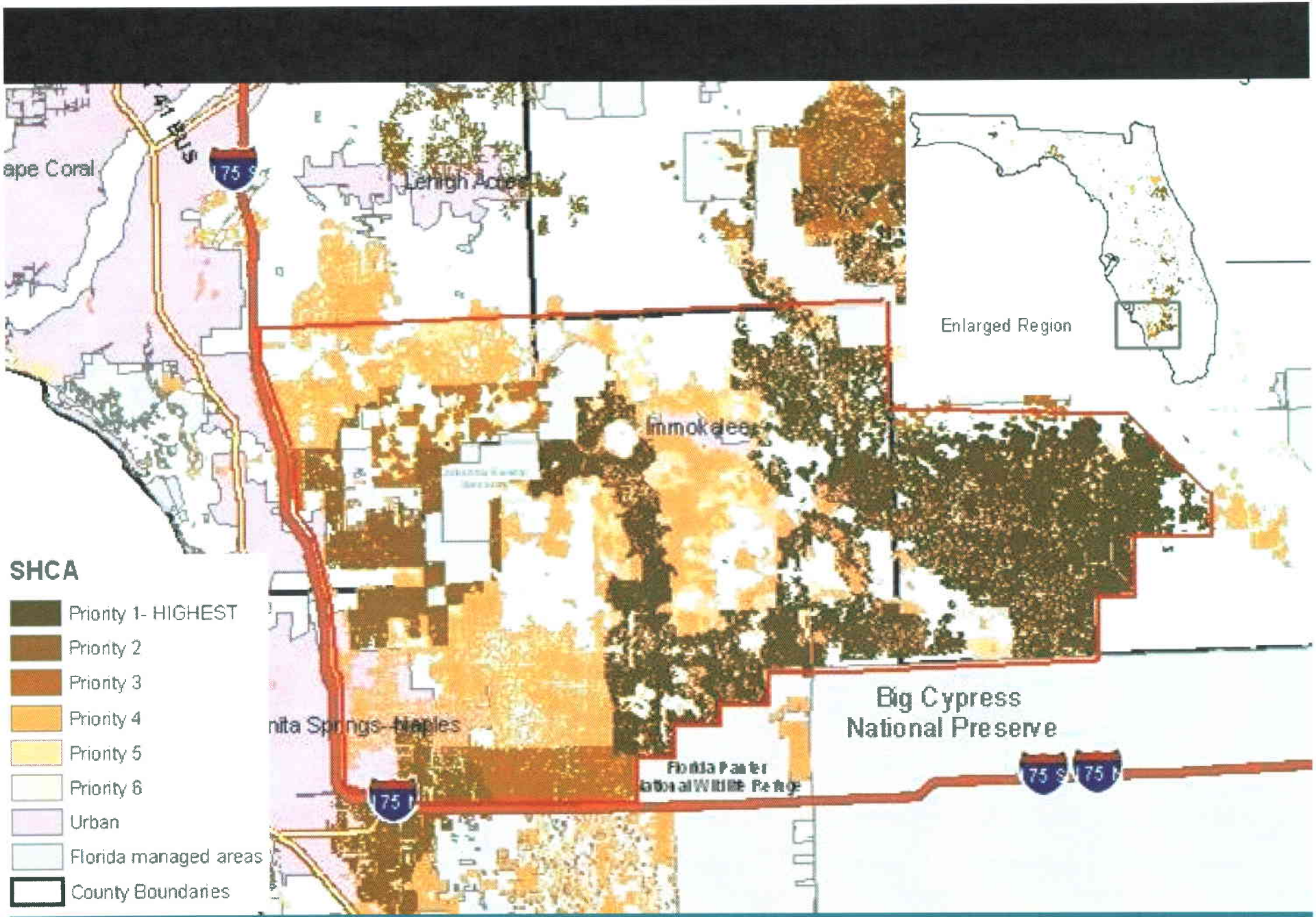
Most of the data are for years 2002-2004 (most recent available)

Florida study area



Reasons for selection of FL case study area

- **Mostly highest and high priority Strategic Habitat Conservation Areas (SHCAs)** (Florida Natural Areas Inventory, 2006) - **uplands and wetland areas that are important habitat and are currently not protected** (Florida Fish and Wildlife Conservation Commission, 2005)



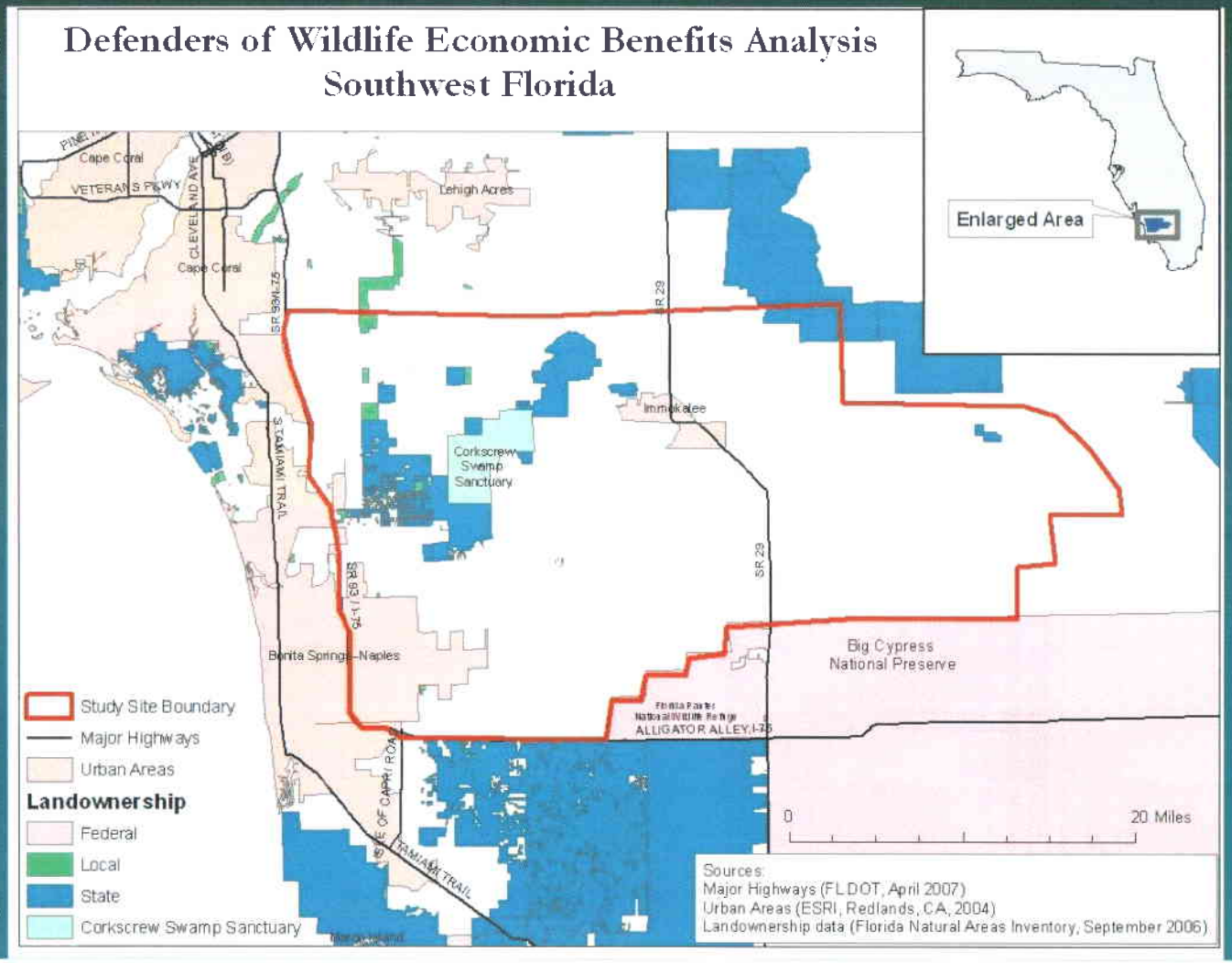
Source: Florida Natural Areas Inventory (2006), figure 1-1

Reasons for selection of FL case study area

- **Mostly highest and high priority Strategic Habitat Conservation Areas (SHCAs)** (Florida Natural Areas Inventory, 2006) - **uplands and wetland areas that are important habitat and are currently not protected** (Florida Fish and Wildlife Conservation Commission, 2005)
- **Contains several of the highest-priority significant landscapes, linkages and conservation corridors and high and highest-priority rare species habitat conservation lands** (Florida Natural Areas Inventory 2006)
- **Vegetation in the area is predominantly characterized as very high threat status in Florida's CWCS** (Florida Fish and Wildlife Conservation Commission, 2005)
- **Mostly prime recharge lands and unprotected recharge lands in natural condition** (The Nature Conservancy, 2005)

Study area characteristics

- 528 thousand acres
- Mostly privately owned



Study area includes over 47,000 acres of protected state, local and private lands, as well as unprotected private "natural" lands.

Ownership of protected lands in the study area

Owner	*Acres*
Collier County	
McIntosh	7
School Board Property - Section 24	66
Winchester Head	5
Red Maple Swamp Preserve	61
Lee County	
Gator Hole Preserve	177
Wild Turkey Strand Preserve	591
Pine Lake Preserve	129
Imperial Marsh Preserve	236
South Florida Water Management District	
Lake Trafford Impoundment	635
Critical Flowway	34
Corkscrew Regional Mitigation Bank	644
Corkscrew Regional Ecosystem Watershed	26,054
Okaloacoochee Slough State Forest	4,654
Private	
Panther Island Mitigation Bank	2,778
Corkscrew Swamp Sanctuary	10,545
Bar Ranch Conservation Easement	562

Overview: Human uses of ecosystems

$ = market impacts ✓ = included in analysis

Direct uses:

- Recreation (wildlife-associated and other) **$** ✓
- Aesthetics (scenic beauty, property value premiums from open space) **$** ✓
- Food, fiber, water **$** ✓
- Education and research **$**
- Cultural ($)

Indirect uses - ecosystem services:

- Air quality **$**
- Water quality (nutrient load reduction) **$**
- Habitat provision: indirectly used species (e.g., pollinators) **$**
- Biodiversity maintenance (genetic resources: crops, pharmaceutical/ medical industry) **$**
- Damage avoidance (carbon sequestration, soil production/retention, waste dilution) **$** ✓(Carbon)

Passive uses:

- Preservation of special species/landscapes (existence and bequest values)

Residential property value premiums from open space

>60 studies in U.S. show that forests, wetlands, nature parks and other open spaces generally increase the sales prices of nearby properties.

→ Recent Meta-analysis of pooled dataset obtained from studies (55 observations) constructs Open Space Property Premium Estimation Model
(Kroeger et al., 2008)

Open space property premiums (contd.)

➔ Application of model to open spaces in study area

- Estimate OS premiums for individual open spaces using satellite imagery and maps
- Use Census 2000 information on median home values for homes in the vicinity (up to 1 mile) of the different open spaces, at the block or block group levels

Total premium for study area residences: est. $130 million at year 2000 real estate prices

Open space premium estimates for study area

Census location		*Number of housing units*	*Median home value in 2000 (2004$)*	*Avg. property premium*	
				% of property value	*Total value (million 2004$)*
Collier Co.	CT 104.07	875	220,469	7.22%	13,928,107
	CT 104.11	1,993	107,405	6.31%	13,507,016
	CT 104.12	1,716	148,694	8.03%	20,489,273
	CT 104.13	741	153,111	5.54%	6,285,417
	CT 104.14	821	141,929	7.22%	8,413,025
	CT 105.03	31	90,502	7.22%	202,562
	CT 112.01	1,206	267,433	3.70%	11,933,391
	CT 112.02	627	124,052	6.28%	4,884,635
	CT 112.04	1,162	81,254	2.77%	2,615,349
	CT 112.05	989	65,289	8.03%	5,185,061
	CT 113	2,318	46,582	5.96%	6,435,419
	CT 114	846	69,390	5.96%	3,498,732
Lee Co.	CT 401.05	174	95,748	5.63%	937,970
	CT 502.02	513	121,550	6.31%	3,934,623
	CT 502.03	242	222,292	5.05%	2,716,629
	CT 503.06	231	94,136	5.63%	1,224,260
	CT 503.08	58	159,205	8.03%	741,480
	CT 503.09	2,399	72,005	7.46%	12,886,475
	CT 503.10	1,163	124,193	6.88%	9,929,991
Hendry Co.	CT 5	8	495,450	8.03%	318,277
					130,067,691

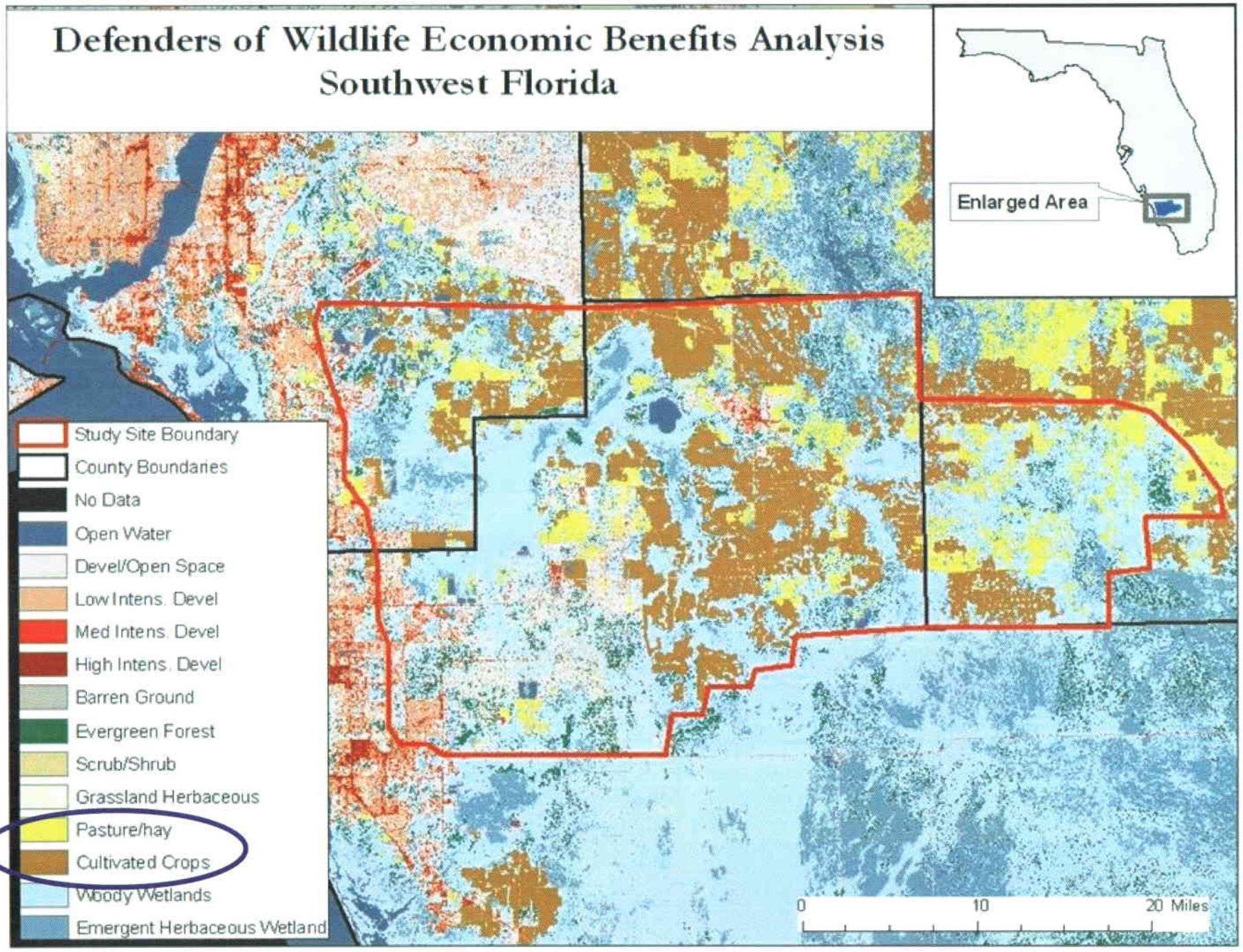
Agricultural production

Most agricultural production in our study area is located in Collier County, followed by Hendry and Lee Counties.





Defenders of Wildlife Economic Benefits Analysis
Southwest Florida



Agricultural production (contd.)

Agricultural acreage in study area

Crop type	*Acres*	*Revenue per acre (2004$)*
Improved Pasture	42,694	14
Unimproved Pasture	14,593	
Citrus	46,026	1,904
Row/Field Crops	35,404	7,043
Other Agriculture	2,517	n/a

Source: Calculated from 2003 Florida Vegetation and Land Cover Data (Stys et al., 2004).

Source: Townsend et al. (2004)

- Average revenue/acre figures for Collier Co. from 2004 IFAS study (Townsend et al., 2004)

Est. revenue from agricultural operations in study area: $372 million in 2000 (at 2004$)

Agricultural production (contd.)

Part of this production value is supported by ecosystem services provided by conservation lands;

Examples:

- pollination (not quantified here)
- water provision (accounted for separately below)

Percentage of crops dependent on native pollinator insects (as opposed to domesticated exotic bees):

- Melons: 10%
- Citrus: 10%
- Squash: 90%
- Cucumber: 10%

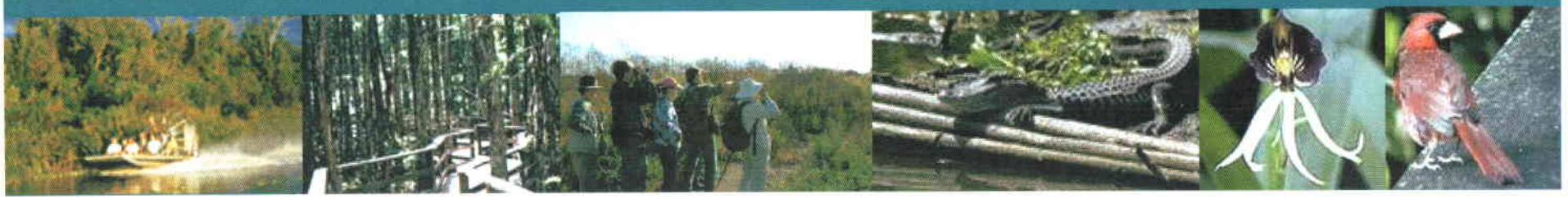
(Losey and Vaughan, 2006)

Recreation

Site	*Primary visitation purpose*	*Estimated visitation, persons/yr*
Corkscrew Swamp Sanctuary	Wildlife viewing, Environmental education	80,000-100,000
CREW	Hiking	>2,000
	Camping	>50
	Environmental education	1,000
	Hunting	318
Lake Trafford	Wildlife viewing	10,000
	Angling	10,000
	Alligator hunting	64

Sources: FWC (2007); Lori Piper (Blair Audubon Center, Corkscrew Sanctuary, pers. comm.); Page Martin (FWC, pers. comm.); Ed Olesky (Lake Trafford Marina, pers. comm.)

- Visitation at CREW probably underestimated (based on voluntary comment cards)



Value of recreation activities

- Economic value is measured as a person's willingness to pay (WTP) for an activity or good
- Only a portion of this is reflected in market expenditures (trip and equipment spending)
- The remainder or "consumer surplus" is the non-market value of the activity received by the participant – the additional amount they would have been willing to spend on the activity (a "personal profit"); it is not reflected in market transactions, but is a **real economic value**

Total recreation value = Spending + Consumer surplus

Trip spending:

Recreation (contd.)

Average trip expenditure of recreationists in Florida per activity day

Avg. trip expenditure per activity day	*Residents*	*Nonresidents*
	2004$	
Wildlife viewing [1]	6	113
Freshwater fishing	41	110
Hunting	24	112

Source: U.S. Fish and Wildlife Service and U.S. Census Bureau (2002) [1] Away from home.

Estimated annual trip spending by recreationists in study area

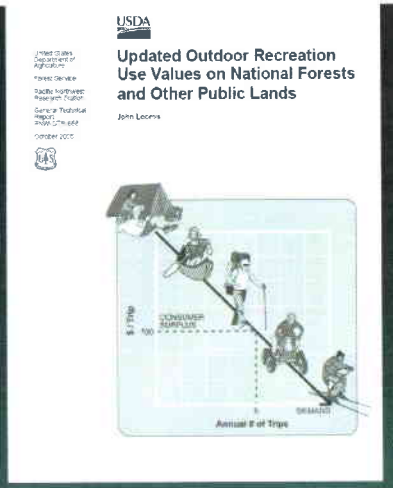
	Residents	*Nonresidents*	*Total*
		2004$	
Wildlife viewing [1]	61,776	593,675	655,451
Hunting	513,207	153,358	666,565
Freshwater fishing	12,427	1,196	13,623
Hiking	12,672		12,672
Total			1,348,312

Total estimated trip spending from recreation in study area: ~$1.3 million/yr. Total impact: $2.4 million/yr in sales; 26 jobs.

Recreation (contd.)

Consumer surplus:

- Based on estimates from peer-reviewed published studies



Activities in study area	*CS per activity day, 2004$*	*Est. number of participants per year*	*Total est. activity days per year*	*Total CS, 2004$*
Wildlife viewing	37.72	90,000	15,000	565,765
Hiking	60.38	2,000	2,000	120,760
Camping	25.79	50	50	1,290
Environmental ed.	- excluded from analysis -			
Hunting	33.66	382	535	18,022
Angling	40.07	10,000	13,931	558,288

Sources: Brown and Hay (1987), Connelly and Brown (1988), Gibbs (1974), Hay (1985), Loomis (2005), Waddington et al. (1991).

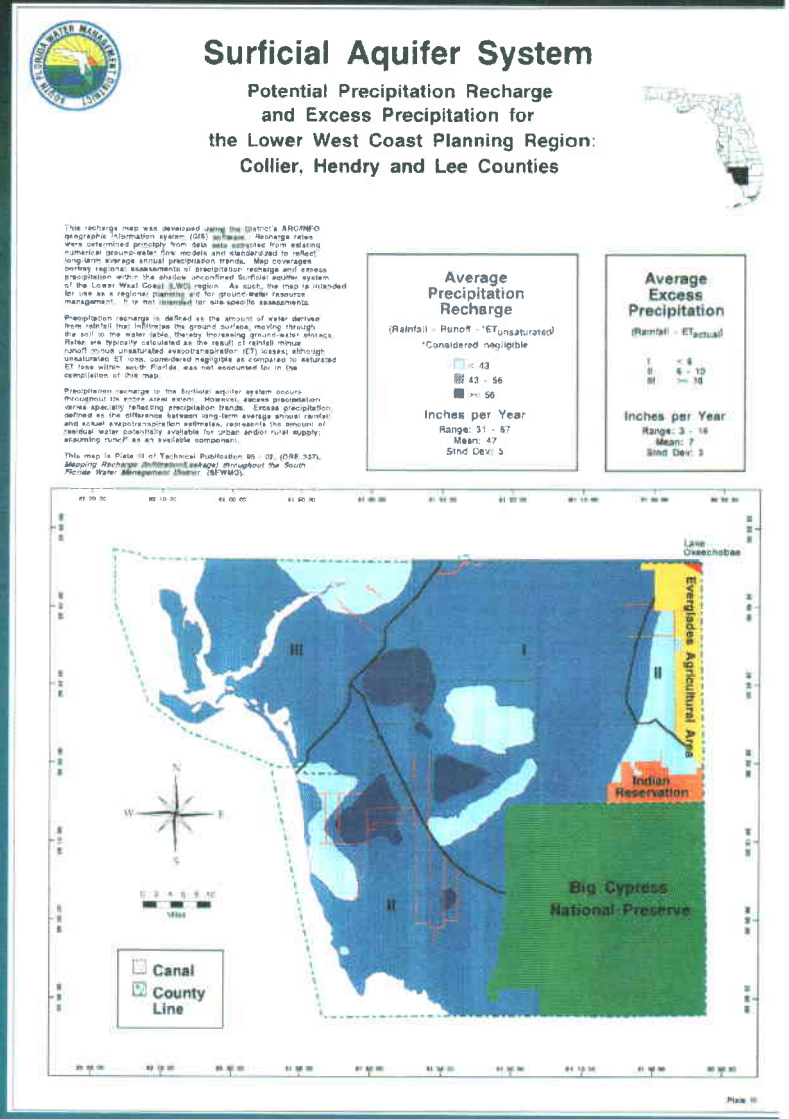
Total annual consumer surplus value for study area:
~$1.3 million /year

Water provision

Infiltration of precipitation - aquifer recharge

- The SAS and IAS provide most of the freshwater supply for public drinking water, agriculture, commercial and industrial uses and landscape irrigation within the Lower West Coast planning area.
- The reliable yield of water from these aquifers plays a significant role in the economy of the region
- The natural recharge of the SAS and IAS in the LWC planning region, which are being drawn down by increasing human water withdrawals, is crucial to counteract saltwater intrusion and comply with wetland drawdown restrictions and other environmental quality considerations

(SFWMD, 2000, 2007a, 2007b).



Source: Fairbank and Hohner (1995)

Water provision

Infiltration of precipitation - aquifer recharge (contd.)

Recharge service volume :

- Total estimated precipitation-based recharge of SAS from study area lands (excluding urban lands):

avg. recharge rate/acre — 43-56 in/yr (Fairbanks and Hohner, 1995

×

non-urban acreage in study area — 476,900 acres = **~1.7-2.2 million ac-ft/yr**

Recharge service value:

- In 2000, SAS and IAS supplied 51% (190 billion gal.) of total human water use in LWC planning area
- ~ 1/3 of total recharge provided by study area lands

➢ Limits of sustainable withdrawal volumes of fresh groundwater are being reached:

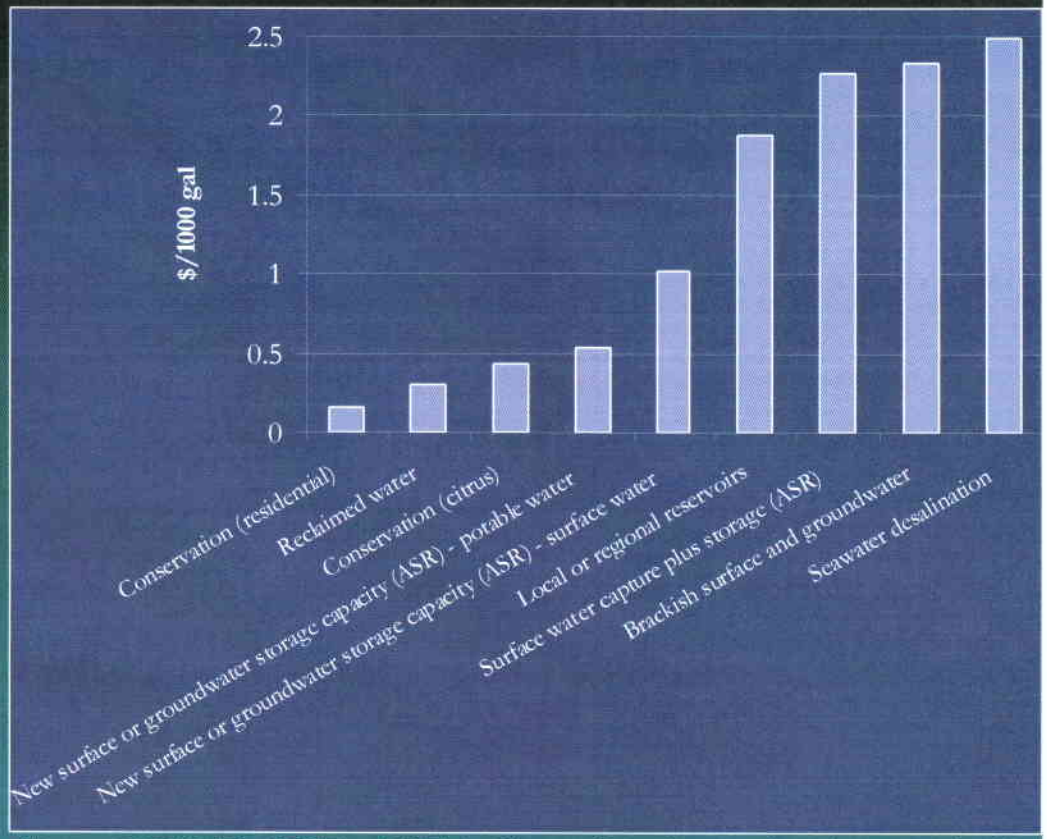
  ➢ SFWMD plans to rely primarily on non-traditional sources to cover future demand increases in LWC planning area

  ➢ Saltwater intrusion into aquifers already occurring

Water provision

Infiltration of precipitation - aquifer recharge (contd.)

1) **Value water at replacement cost = cost of alternative water sources**
   (traditional sources are at their limits; SFWMD plans to rely mostly on non-traditional sources for future demand increases)
2) **Develop scenarios for quantities obtainable from non-traditional sources (SFWMD, 2007a,b)**
3) **Use costs of those sources to value recharge-based withdrawals**
   (starting with lowest-cost sources)



Sources: SFWMD (2007a, 2007b). Cost of local or regional reservoirs is based on St. Johns County Civic Association Roundtable (2006).

Est. value of withdrawals from SAS and IAS:

Scenario 1 (low-cost): $130 million/yr

Scenario 2 (medium cost): $285 million/yr

Carbon sequestration

- Study area: 528,000 ac
- 55 percent (291,000 acres) in non-agricultural lands featuring woody biomass

Class	*Acres*	*Class*	*Acres*
Sand/Beach	1	Open Water	10,451
Dry Prairie	24,975	Shrub and Brushland	1,131
Mixed Pine-Hardwood Forest	2,105	Bare Soil/Clearcut	44,729
Hardwood Hammocks and Forest	12,013	Improved Pasture	42,694
Pinelands	64,968	Unimproved Pasture	14,593
Cabbage Palm-Live Oak Hammock	694	Citrus	46,026
Freshwater Marsh and Wet Prairie	41,466	Row/Field Crops	35,404
Shrub Swamp	18,140	Other Agriculture	2,517
Cypress Swamp	56,353	Australian Pine	4
Cypress/Pine/Cabbage Palm	8,612	Brazilian Pepper	65
Mixed Wetland Forest	37,984	High Impact Urban	30,838
Hardwood Swamp	22,404	Low Impact Urban	8,497
Mangrove Swamp	1	Extractive	1,189
		Total acreage:	527,854

Carbon sequestration (contd.)

Located studies giving **annual net C sequestration rates** for vegetation types found in study area

Ecosystem type	*Location*	*kg C/ha/yr*	*C stocks included in analysis*	*Source*
Slash pine	South-central Florida	6,750	Total aboveground biomass and coarse roots	Clark et al., 1999
Cypress	South-central Florida	605	Total aboveground biomass and coarse roots	Clark et al., 1999
Southern hardwoods	Tennessee	5,250	Total aboveground biomass and coarse roots	Greco and Baldocchi, 1996
Pine-spruce wetland	Florida	4,260	Total aboveground and soil organic carbon	Li et al., 2004

- Data gaps filled with estimates from recent IFAS study of net C sequestration (woody biomass only!) from non-urban plots in Tampa (underestimate C uptake in study area)
- **But**: no net sequestration estimates available for freshwater marsh, wet prairie, shrub and brush lands.

Carbon sequestration (contd.)

Net sequestration estimates for vegetation types in the study area

Vegetation type	*Presence in study area*	*Avg. C sequestration*	
	ha	*kg/ha/yr**	*tons/yr*
Dry Prairie	10,107	58	586
Mixed Pine-Hardwood Forest	852	6,000**	5,111
Hardwood Hammocks and Forest	4,862	5,250**	25,523
Pinelands	26,292	6,750**	177,468
Cabbage Palm-Live Oak Hammock	281	407	114
Freshwater Marsh and Wet Prairie	16,781	n/a	n/a
Shrub Swamp	7,341	1,417	10,401
Cypress Swamp	22,806	4,220	96,229
Cypress/Pine/Cabbage Palm	3,485	3,677**	12,817
Mixed Wetland Forest	15,372	1,704	26,197
Hardwood Swamp	9,067	5,785	52,447
Mangrove Swamp	<1	7,796	2
Shrub and Brushland	458	n/a	n/a
TOTAL			406,895

Notes: n/a not available. *Unless otherwise indicated, values are based on IFAS data. **Based on literature data.

>400,000 tons net of C per year / 1.6 tons per acre

Does not include:

- sequestration through soil organic matter and root biomass
- C storage in freshwater marsh and wet prairies

Carbon sequestration (contd.)

Value of C sequestration

= avoided (reduced) damages from climate change.

- difficult to estimate

Alternative: Use market prices for C to value sequestration services

Q: Which markets? What admissibility requirements? (verifiability, additionality, permanence and leakage)

1) Mandatory (regulation-based) markets

- Currently, U.S. landowners cannot sell in regulated markets (EU, UK, Norway, Australia, CDM, JI) because U.S. not a participant
- But: regulated markets expected to start operating in U.S. (RGGI, CCAR, Western Regional Climate Initiative; federal regulation?)

2) Voluntary markets

- CCX (Chicago Climate Exchange)
- private C offsets sellers (several dozen suppliers)

Carbon sequestration (contd.)

Value of C sequestration (all 2004$)

CCX: avg. price Jan.-July 2007: $3.41/metric tCO_2e - *LOW scenario*

(currently: $7.06/metric tCO_2e)

Private offset suppliers: avg. 2006/2007: $14.20/metric tCO_2e - *HIGH scenario*

	LOW scenario	*HIGH scenario*
Quantity of C sequestered (metric tons)	406,895	
Corresponding quantity of CO_2 (metric tons)	1,492,085	
Price per ton of CO_2 (2004$)	3.41	14.21
Value of carbon sequestration (2004$)	5,088,052	21,202,954

Study area lands could generate carbon sequestration credits worth over $5 million/year

C prices likely to increase in the future.

Summary

- Natural and agricultural lands in the study area support a variety of uses that generate substantial market values
- They also provide economic benefits that (currently) do not result in market transactions (e.g., biodiversity conservation, climate change mitigation)
- The increasing scarcity of the benefits provided by these lands (open space, biodiversity maintenance, water provision, carbon sequestration) will increase the value of these uses/services in the future; hence, protection of these lands is likely to make even more economic sense in the medium- and long-term

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Open space property premiums (contd.)

Model estimates open space property value premiums as a function of:

- **% of an area** that is covered by the specific open space of interest
- **land cover characteristics** (forest, park, pasture, wetland)
- **land ownership** (private, public, mixed)
- whether land is **protected** or not

Findings:

- 10% increase in the percentage of open space in an area increases property values on average by 3.5%;
- marginal premiums decrease for successively larger open spaces
- premium is higher for forested, private, or protected open space or for natural area parks
- premium is lower for agricultural open space
- Final open space premium estimation model explains 54% of observed variation in open space premiums