Table 7. Summary of Late Quaternary Geochronology and Sea-Level Status along the Florida Reef Tract

	Event/Evidence		~Lower sea level (m) relative to present	(ka)	Oxygen-isotope stages	Authors	Dating methodologies
Holocene							
	Florida and Biscayne Bays flood		slowing rise (at 2)	~0.5		Lidz and Shinn, 1991	based on Robbin, 1984
	Carysfort Reef grows		slowing rise	4.8 to 4.8†		Multer et al., 2002	TIMS
	Long Reef grows		slowing rise	6.3 to 5.8†		Shinn et al., 1977	cal. yr B.P.
	Upper Keys shelf floods		slowing rise	~7.1		Lidz et al., 1997a	based on Robbin, 1984
	Sand Key outlier crest ridge dies		slowing rise	7.1 to 6.8†		Toscano and Lundberg, 1998	TIMS
	Mangroves SW of Marquesas Keys		slowing rise (> 6.7)	7.2 to 6.8†		Robbin, 1984	cal. yr B.P.
	Carysfort Reef grows		slowing rise	7.7 to 7.3†		Toscano and Lundberg, 1998	TIMS
	Fort Lauderdale barrier reefs die		rapid rise	7.8 to 7.5†		Lighty et al., 1978	cal. yr B.P.
	Marker G reef grows		rapid rise	7.8 to 7.5†		Shinn et al., 1977	cal. yr B.P.
	Lower Keys shelf floods		rapid rise	~8.1		Lidz et al., 1997a	based on Robbin, 1984
	Sand Key outlier crest grows		rapid rise	8.3 to 8.1†		Ludwig et al., 1996	TIMS
	Mangroves at Alligator Reef		rapid rise (> 7.2)	8.6 to 8.2†		Robbin, 1984	cal. yr B.P.
	Fort Lauderdale reef grows		rapid rise	9.0 to 8.6†		Lighty et al., 1978	cal. yr B.P.
	Shoreline facies off Pelican Shoal		stillstand (at ~25)	~9.1		Lidz et al., 2003	based on Robbin, 1984
	Shoreline ridge(?) off Pelican Shoal		stillstand (at ~30)	~9.2		Lidz et al., 2003	based on Robbin, 1984
	Mangroves at Alligator Reef		rapid rise (> 7.4)	9.4 to 8.4†		Robbin, 1984	cal. yr B.P.
(F)	Sand Key outliers grow		rapid rise	9.8 ± 8.0†		Toscano and Lundberg, 1998	TIMS
	Tortugas Bank reefs grow	(13)	rapid rise	~9.6†	← 1	Mallinson et al., 2003	TIMS
Pleistocene							
	Marquesas S4 drowns		rapid rise			Locker et al., 1996	
	Marquesas shoreline S4 forms		stillstand (at 65)	~13.8‡		Locker et al., 1996	AMS ^{14}C - CRA
	Marquesas S3 drowns		rapid rise			Locker et al., 1996	
	Marquesas shoreline S3 forms		stillstand (at 71)	~14.0‡		Locker et al., 1996	AMS ^{14}C - CRA
	Marquesas S2 drowns		rapid rise			Locker et al., 1996	
	Marquesas shoreline S2 forms		stillstand (at 80)	~14.5‡		Locker et al., 1996	AMS ^{14}C - CRA
	Marquesas S1 drowns		rapid rise			Locker et al., 1996	
	Marquesas shoreline S1 forms		stillstand (at 124)	~18.9‡		Locker et al., 1996	AMS ^{14}C - CRA
			rapid rise	~20.0		Milliman and Emery, 1968	
	Sea level at major lowstand		lowstand (> 130)			Chappell and Shackleton, 1986	
		(12)	highstand (~41)	30.0§	2	Bloom et al., 1974; Chappell, 1974	
			lowstand	?			
		(11)	highstand (~38)	50-40§	3	Bloom et al., 1974; Chappell, 1974	
			lowstand	?			
		(10)	highstand (~28)	60.0§	4	Bloom et al., 1974; Chappell, 1974	
	Prolonged platform exposure		rapid fall	?		Toscano and Lundberg, 1999	
	Carysfort Reef grows		highstand	77.8§	5a	Multer et al., 2002	MC-ICP-MS
	Sand Key outliers grow		highstand (~9)	~83-80§	5a	Ludwig et al., 1996; Toscano and Lundberg, 1999	TIMS
	Carysfort Reef grows		highstand (~9)	85.3§	5a	Toscano and Lundberg, 1999	TIMS
(E)	Sand Key outliers grow	(9)	highstand (~9)	86.6§	← 5a	Ludwig et al., 1996	TIMS
			lowstand				
(D)	Sand Key outliers grow	(8)	highstand (14-10)	94-90§	← 5b	Toscano and Lundberg, 1999	TIMS
			lowstand				
			highstand	~105.0§	5c	Bloom et al., 1974; Chappell, 1974	
(C)	Sand Key outliers grow	(7)	highstand (~15)	~106.5§	← 5c	Toscano and Lundberg, 1999	TIMS
	Hiatus in records; Q5 Unit unconf. forms		lowstand (70-80)	~110.0	5d	Steinen et al., 1973; Perkins, 1977	
	Q5 Key Largo Ls. & marine unit form		highstand (at ~+10.6)	~125.0§	← 5e	Hoffmeister and Multer, 1968	
	Miami Limestone oolite facies forms	(6)	highstand	~125.0	5e	Hoffmeister and Multer, 1968	
(B)	Sand Key outliers grow(?)		rising	~125.0	5e	Lidz et al., 2003	Event/timing inferred
			lowstand(?)				
(A)	Sand Key dune ridges colonized(?)	(5)	highstand	~127.0	6	Chappell, 1974; Lidz et al., 2003	Event/timing inferred
	Dune ridges form on terrace(?)		lowstand	~190.0		Lidz et al., 2007	Event/timing inferred
	Q4 Unit unconformity forms		lowstand	~190.0§		Perkins, 1977	
	Upper-slope terrace forms(?)		falling	~190.0		Lidz et al., 2007	Event/timing inferred
	Q4 Key Largo Ls. & marine unit form		highstand	~230.0	← 7	Muhs, 2002; Muhs et al., 2004	U-series, $\partial^{18}O$
	Miami Ls. bryozoan facies forms	(4)	highstand	~230.0		Hoffmeister and Multer, 1968	
	Q3 unconformity forms		lowstand	<366.8§		Perkins, 1977	
	Q3 Key Largo Ls. & marine unit form	(3)	highstand	~366.8§	← 9	Multer et al., 2002	TIMS
	Q2 unconformity forms		lowstand	?		Multer et al., 2002	
	Q2 Key Largo Ls. & marine unit form	(2)	highstand	?	11(?)	Perkins, 1977	
	Q1 unconformity forms		lowstand	?		Multer et al., 2002	
	Q1 Key Largo Ls. & marine unit form	(1)	highstand	?	11(?)	Perkins, 1977	

Notes: Table is read chronostratigraphically from bottom to top. Fluctuating sea level was the primary control on all events.

(A-F): Dated corals document four periods of outlier-reef growth off Sand Key between 106.5 ka and 6.9 ka (C-F). Two older growth periods are inferred at the Stage-6/substage-5e transition (A-B), during which corals are believed to have initiated outlier-reef development at ~127 ka and continued to accrue through substage-5e time.

Marquesas S1-S4, left column: Four subtidal, shoal, dune-ridge complexes formed a series of elevated, shore-parallel upslope shorelines during a pulsating rise in sea level at the end of the Pleistocene. A fifth pulsation produced a shoreline-associated change in sediment stratification off Pelican Shoal (Fig. 3.26a; Lidz et al., 2003).

(1-13): At least 13 periods of marine highstands occurred. Alteration of original mineralogy within the Q3 and Q4 Units has rendered radiometric coral dates for those stratigraphic sections uncertain (Szabo and Halley, 1988; Muhs et al., 1992). Assignments of isotope stages to the Q1-Q4 Units are tentative (Multer et al., 2002). Three highstands (#10-12) remained below elevation of the shelf.

Abbreviations: unconf.—unconformity; Ls.—Limestone; AMS—accelerator mass spectrometry; CRA—conventional radiocarbon age; MC-ICP-MS—multicollector inductively coupled plasma mass spectrometry; TIMS—thermal ionization mass spectrometry; U-series—uranium series; $\partial^{18}O$—variations in marine oxygen isotope.

†Radiometric dates in ka based on cal. yr B.P. 2-sigma ranges for conventional radiocarbon ages.

‡Conventional radiocarbon ages based on accelerator mass spectrometer (AMS) ^{14}C dating of ooids corrected for an assumed air-sea reservoir effect of -400 years.

§Abbreviated radiometric dates: no indications of precision were reported for dates obtained by Mitterer (1974) and cited by Perkins (1977; Q2 at 324 ka, Q3 at 236 ka, Q4 at 180 ka, Q5 at 134 ka). The amino-acid age-dating method used in the 1970s and the more recent U-series age-dating method are sensitive to environmental factors and subject to error (Schroeder and Bada, 1976; Muhs et al., 2004). Using TIMS, Multer et al. (2002) obtained actual Q3-Unit dates of 366.8 and 370.2 ka.

Arrows: Dated lithofacies in Florida represent seven periods of Quaternary coral growth—during accumulation of (a) stratigraphic units Q3, Q4, and Q5 of Perkins (1977), the Q5 Unit correlating with deep-sea oxygen-isotope substage 5e, and (b) younger corals that date to substages 5c, 5b, 5a, and Stage 1 (the Holocene).