Map Unit Properties Table: Dry Tortugas National Park

Bold text corresponds to headings in the Geologic Features and Processes, Geologic Issues, and Geologic History sections of the report. Colors in the "Map Unit" column correspond to colors on the Benthic Map Graphic (in pocket).

Age	Map Unit (Symbol)	Benthic Description		Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Holocene)	Unconsolidated Sediment (US)	Unconsolidated sediments with less than 10% colonization by corals or submerged aquatic vegetation. Sediments may consist of mud, sand, granules, pebbles, cobbles, shell hash, or detrital material (e.g., seagrass, algae, and leaf litter).		**Unconsolidated Benthic Sediments—** Unconsolidated sediments cover approximately 50% of the ocean floor within the park. Coarser sediments dominate the sand banks and fine sediments are found in the deeper areas of the lagoon. **Paleontological Resources—**The oldest unconsolidated sediments have been dated back to 10,000 years (Multer et al. 2002; Mallinson et al. 2003; Shinn et al. 1977). Sands contain particles of calcified algae and coral.	**Sediment Erosion and Accretion—**A channel between Garden and Bush Keys has opened and closed repeatedly since at least the early 1900s. The channel was dredged once in 1905, closed in 2000, reopened in 2004, and closed again in 2012. At the time of writing this report the channel is closed.	Broken down remains of preexisting reef building organisms from up to 10,000 years ago.
	Submersed Rooted Vascular Plants: Continuous SRV (CSRV)	Habitat with 10% or more cover of Submersed Rooted Vascular Plants (SRV) (i.e., seagrasses and oligohaline grasses).	Continuous beds of SRV of any shoot density (i.e., sparse continuous, dense continuous, or any combination). These areas appear as continuous seagrass signatures; however, small (less than 0.2 ha [0.5 ac]) areas of bare sediment may be observed as infrequent features.	**Seagrass Beds—**Seagrass beds occupy a discontinuous ring which parallels the linear reefs on the lagoon side. A large region of continuous SRV exists in the center of the lagoon. Seagrasses occupy approximately 14% of the area of the park. Seagrasses increase sediment accumulation rates by trapping sands and other fine particles that would otherwise be carried away by currents. Their roots and rhizomes also help to stabilize the seabed. Once stabilized, seagrasses provide coastal protection against waves and erosion, and a safe harbor for marine life, including juvenile exploited reef fish species.	**Sea Level Rise—**Further research is needed to understand how the benthic environment will respond to changes in sea level. Sea level rise counteracts sediment accumulation around seagrass beds. However, if sea level rise is rapid, it may drown seagrass beds. **Hurricanes and Storms—**As of May 2007, 19.7 ha (48.7 ac) of seagrass meadows had been destroyed around Loggerhead and Bush Keys as a result of 2004–2005 hurricanes and subsequent winter and tropical storms (Morrison 2010). This loss is equivalent to nearly half of the land area in the park. Additional loss occurred in 2009 during Hurricane Ike. **Recreation and Commercial Uses—**Boat anchoring is harmful to seagrass beds.	SRV plays an important role in sedimentation, which is an ongoing geologic process. Areas of SRV have high sedimentation rates.
	Submersed Rooted Vascular Plants: Discontinuous SRV (DSRV)		Areas of SRV with breaks in coverage that result in isolated patches of SRV, usually in unconsolidated bottom but also exist in hardground areas. Generally, these grass features appear as semi-round patches or elongated strands separated by bare sediment.			

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Age	Map Unit (Symbol)	Benthic Description		Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Holocene)	Coral Reef — Linear — Reef Terrace (RT)	Linear, contiguous coral formations.	Reefs with high complexity and relief greater than 2 m (7 ft). Most often has associated spur and groove and reef rubble habitats.	**Holocene Coral Reefs—**Reef terraces form a discontinuous ring around the outside of the islands and sand banks of the park. The largest area of reef terrace is northwest of Loggerhead Key. The longest continuous stretch is located near the park's northern boundary. Reef terraces occupy about 7% of the area of the park.	**Sea Level Rise—**Some rise in sea level is beneficial for corals because it gives them vertical room to grow. Corals are at risk of becoming drowned if their upward growth rate cannot keep pace with the rate of sea level rise. **Hurricanes and Storms—**Living reefs in the park are survivors of intense and frequent storm activity (Multer 1977). Reef crests and shoals typically receive the brunt of the damage (Jindrich 1972). Regeneration of reefs following a storm is a slow process. Storm-resistant coralline algae and fire coral species (*Millepora sp.*) are taking over habitat previously occupied by branching corals (*Acropora palmata* and *A. cervicornis*) (Jindrich 1972; Multer 1977; Reynolds and Steinmetz 1983). **Coral Reef Rehabilitation—**Protection and preservation of pristine coral reefs is part of the park's enabling legislation. Two species of threatened coral (*A. palmata* and *A. cervicornis*), which may be reclassified as endangered, are found within the park. Continued research and monitoring efforts will determine the best way to protect reefs and encourage new reef growth. **Recreation and Commercial Uses—**Intensive snorkeling and diving activity and boat anchoring is harmful to coral reefs. Impacts include physical contact with coral, decreased water clarity, littering, and pollution. The effects on park reefs from these activities are being assessed (Miller et al. 2010; Morrison 2010; Morrison et al. 2010; Ruzicka et al. 2012).	**Holocene Epoch: Living Coral Reefs—**Living reefs are established on top of Pleistocene reefs. Their location mimics the former locations of reefs that existed more than 125,000 years ago (Tilmant 1993; Davis 1997; Toscano et al. 2010).
			Reefs of relief less than 2 m (7 ft) that lack distinctive spur and groove characteristics. These reefs consist of coral and hard bottom features; often support soft corals, sponges, and seagrass; and are usually found growing parallel to the reef tract, though they may form transverse features that grow perpendicular to the reef tract.	**Holocene Coral Reefs—**Remnant reefs are distributed similarly to reef terraces, although the bands tend to be thicker and more continuous. The largest area of remnant reef occurs near the park's northern boundary. Remnant reefs occupy about 16% of the area of the park.		
	Remnant (RM)					
	Spur and Groove — High Relief Spur and Groove (HRSG)	Distinct coral bands (spurs) separated by sand or uncolonized hardbottom (grooves). This habitat type usually occurs in the fore reef zone.	The coral bands have 1.5 to 4 m (5 to 13 ft) of relief.	**Holocene Coral Reefs—**Bands of low relief spurs and grooves line the northwestern perimeter of the park where wave energy is less intense. High relief spurs and grooves are prominent in the southeast. Spurs dampen the energy of incoming waves, helping to protect the more fragile reef crests (Shinn et al. 1989). Spur and groove habitat make up only about 2% of the area of the park.		
	Low Relief Spur and Groove (LRSG)		The coral bands are oriented perpendicular to the shore or bank and have less than 1.5 m (5 ft) relief.			
	Reef Rubble (RR)	Dead, unstable coral rubble that often occurs landward of platform reefs.		**Holocene Coral Reefs—**Reef rubble occupies a very small part of the benthic environment (less than 0.5%). The largest concentration is on the lagoon side of Southeast Reef. **Geologic Materials Used in Fort Jefferson—**Coral rubble from outlying reefs appears to have been mixed in with cement made on-site and used in fort construction (Davis 1997).	None documented.	**Holocene Epoch: Living Coral Reefs—**Rubble provides evidence of formerly dominant species such as the threatened elkhorn and staghorn corals.

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Age	Map Unit (Symbol)	Benthic Description		Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Holocene)	Coral Reef > Patch > Individual Patch Reef (IPR)	Irregularly shaped reef communities. They may range in size from tens to thousands of square meters. Patches are separated from each other by uncolonized hard bottom, sand, or colonized substrate with submerged aquatic vegetation, macroalgae, gorgonians or sponges. Most often the patches are surrounded by a halo or bare substrate created by foraging, obligate reef inhabitants.	Isolated, single reef without associated halo area. Individual reefs may have an associated halo. However, if the halo is large enough to be delineated at map scale, it is mapped as its own subclass.	**Holocene Coral Reefs—**Patch reefs are mostly found on the lagoon side of the islands. They are frequently surrounded by seagrass or sand. A large concentration of aggregated patch reefs exists southwest of Loggerhead Key. Patch reefs occupy less than 5% of the area of the park.	**Sea Level Rise—**Some rise in sea level is beneficial for corals because it gives them vertical room to grow. Corals are at risk of becoming drowned if their upward growth rate cannot keep pace with the rate of sea level rise. **Hurricanes and Storms—**Living reefs in the park are survivors of intense and frequent storm activity (Multer 1977). Reef crests and shoals typically receive the brunt of the damage (Jindrich 1972). Regeneration of reefs following a storm is a slow process. Storm-resistant coralline algae and fire coral species (*Millepora* sp.) are taking over habitat previously occupied by branching corals (*A. palmata* and *A. cervicornis*) (Jindrich 1972; Multer 1977; Reynolds and Steinmetz 1983). **Coral Reef Rehabilitation—**Protection and preservation of pristine coral reefs is part of the park's enabling legislation. Two species of threatened coral (*A. palmata* and *A. cervicornis*), which may be reclassified as endangered, are found within the park. Research and monitoring efforts should be directed toward determining the best way to protect reefs and encourage new reef growth. **Recreation and Commercial Uses—**Intensive snorkeling and diving activity and boat anchoring is harmful to coral reefs. Impacts include physical contact with coral, decreased water clarity, littering, and pollution. The effects on park reefs from these activities are being assessed (Miller et al. 2010; Morrison 2010; Morrison et al. 2010; Ruzicka et al. 2012).	**Holocene Epoch: Living Coral Reefs—**Living reefs are established on top of Pleistocene reefs. Their location mimics the former locations of reefs which existed more than 125,000 years ago (Tilmant 1993; Davis 1997; Toscano et al. 2010).
	Coral Reef > Patch > Aggregated Patch Reefs (APR)		Clustered patch reefs, usually too small or too close together to map individually. Aggregated patch reefs may also occur where halos coalesce. Includes halo areas if present.			
	Coral Reef > Patchy Coral and/or Rock in Unconsolidated Bottom (PCRUB)	Areas of primarily sand, submerged aquatic vegetation or low relief rock covered with a sand veneer. Often adjacent to spur and groove habitats. These areas contain small, individual corals or rocks that are distinctive yet a very low percentage of the total cover.		**Holocen Coral Reefs—**Approximately 4% of the park is covered by this map unit. The largest area is a discontinuous eastward thinning curved band extending from off the coast of Long Key to the south of Hospital, Middle and East keys.		
	Pavement (PVT)	Flat, low relief, mostly solid rock substrate composed of bedrock or created through syndepositional cementation of sediment (i.e., "hardground").		**Pavement—**Pavement represents less than 1% of the area of the park. The highest concentration of pavement exists around Loggerhead Key, particularly to the southwest. Octocoral communities are established in some places (Davis 1979).	None documented.	Pavement formation is a geologic process occurring in the park today. Pavement forms where calcite precipitated form algae or directly from the seawater partially cements unconsolidated sediments on the seafloor.

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QUATERNARY (Holocene)	Land (Land)	Mainland, islands, causeways, and other land normally above the high tide line. The line delineating the water/land interface may be formed anywhere between the extreme low and extreme high tide marks.	**Islands and Sediment Transport—**Islands make up only about 0.2% of the area of the park. Currently seven islands composed of unconsolidated sand and coral rubble exist in the park. Beachrock is present on Loggerhead Key. The size, shape, and location of the islands are constantly changing. **Paleontological Resources—**The islands are composed of fossil material including particles of coral skeleton, coralline algae, mollusk shells, and foraminifera.	**Sea Level Rise—**Half of the coastline in the park is highly vulnerable to the physical effects of sea level rise (Pendleton et al. 2004). The very gentle slope of the coast indicates that inundation will occur rapidly under rising sea level conditions. **Hurricanes and Storms—**Hurricanes and storms can alter island morphology drastically, eroding large sections of beach in only a few hours. Waves produced by storm and hurricane winds are capable of moving large quantities of sediment very quickly. The larger and more powerful the wave, the larger the sediment size it is able to transport. Boulder size coral rubble can be moved by hurricane-generated waves. **Sediment Erosion and Accretion—**Erosion and accretion are affecting facilities on Garden Key. Sand is accreting behind a dock and at two moat locations. The shoreline between the seaplane ramp and the north coaling dock is eroding. The channel between Garden Key and Bush Key has opened and closed several times. **Subsidence**—Fort Jefferson is unevenly subsiding atop the sands and coral rubble that make up Garden Key. Efforts to stabilize the fort are ongoing. **Groundwater Flow and Salinity—**Nutrients from waste enter the marine environment via groundwater flow and surface runoff where they may have deleterious effects on marine organisms and habitats. The relationship between groundwater flow dynamics and overall marine quality must be quantitatively determined (Thornberry-Ehrlich 2005).	Shape, size, location, and existence of islands are a result of geologic processes.