Coral Reef Assessment: An Index Utilizing Sediment Constituents

C. Daniels¹, P. Hallock¹

¹College of Marine Science, University of South Florida, St. Petersburg, Florida, USA

**Introduction**

In order to effectively conserve the coastal wetland effects and coral reef protection and restoration, resource managers need inexpensive indicators to assess the health of coral reefs. Reef sediments are a natural source of such indicators due to their potential to reflect the activities of important reef processes. Coral reefs are one of the most diverse and productive marine habitats in the world, supporting a variety of wildlife, including fish, crustacea, and echinoderm. These resources are particularly vulnerable to the effects of climate change, including rising sea temperatures and ocean acidification. To properly care for and conserve these resources, a rapid assessment protocol is needed to determine the health of coral reefs and to inform decisions on when and where to utilize more expensive assessment techniques.

**Rationale**

Reef sediment composition is an indicator of the dominant processes influencing community structure and can provide insight into coral reef health. This study aims to evaluate the health of coral ecosystems and to inform decisions on when and where to utilize more expensive assessment techniques. We have developed the SEDCON Index (SI), a rapid-assessment protocol that utilizes reef sediment composition to assess the integrity of coral-reef communities. Implementation and assessment of this diagnostic tool has been completed for the Florida Middle Grounds (FMG) and the Coral Reef Evaluation and Monitoring Program (CREMP) sites in the Florida Keys National Marine Sanctuary (FKNMS).

**Index Formula**

- **SEDCON Index (SI) equation:**
  \[ SI = (10^*P_c) + (8^*P_f) + (2^*P_u) + (0.1^*P_e) \]

  **Magnitude of values indicate dominant process**
  - Higher values reflect conditions favoring accretion
  - Lower values reflect dominance of bioerosion

**Results**

- **Key Largo Replicates (One Way ANOVA)**
  - Between Sites 3.093 9 0.343 25.753
  - Within Sites 0.017 1 0.017 0.098 0.756

- **CREMP (Two Way ANOVA—3 year data)**
  - Among Sites 2.731 10 0.273 4.286
  - Between Sites 3.093 9 0.343 25.753
  - Within Sites 0.017 1 0.017 0.098 0.756

**Materials and Methods**

1. Collection of fore-reef surficial sediments, ~10g per sample
2. Wet sieve each sample and place into drying oven (50-80°C)
3. Dry sieve for grain size analysis (Folk, 1974)
4. Sprinkle 1g of sediment from 0.5-2mm range onto gridded tray and archive residual sample
5. Constituent analysis of 300 sediment grains under a stereomicroscope
6. Data entry
7. Principle Component Analysis information was obtained using both sediment constituent data and SI values. According to this data for the Florida Reef Tract, bioerosion and autotrophy were the dominant processes. Conditions favoring accretion were not represented at any of the Florida Keys sites.

**Conclusions**

- Strengths: discrimination between sites and low intrasite variability (2-3 samples sufficient)
- Restrictions: no interannual responses and depth limited
- Index should only be used for periodic assessments (≥ 5 yrs.) and applied to sites <20m
- Bioerosion has overtaken accretion in the Florida Keys

**Future Investigation**

- Subsequent work will focus on adjusting the SEDCON Index equation to discriminate more effectively between sites controlled by auto or heterotrophy (mid SI) and sites dominated by bioerosion (low SI).
- Compare SI data to other independent parameters used to assess coral reef health (species diversity, mortality vs recruitment)

**Acknowledgements**

- NOAA-URC
- Florida Wildlife & Research Institute’s Coral Reef Monitoring Program: Carl Beaner and Walt Jaap for data access
- Michael Callahan - sample collection and other data from CRMP sites
- Dr. Dana Williams, Elizabeth Carnahan, & Elizabeth Fisher – sample collection

---

**References**

- Birkeland (1987), Hallock et al. (1988)
- Spearman R = 0.48 p-value = 0.00
- Vegan R = 0.754
- **Cal Alg**
  - 10%
  - 23.4%
  - 13.2%
- **Sym For**
  - 13%
  - 81%
  - 81%
- **Ech Spi**
  - 4%
  - 0.5 cm0.5 cm
- **Prp**
  - 30.0%
  - 30.0%
- **Cal Alg**
  - 13.2%
  - 35.0%
- **Gastro**
  - 4%
  - 1.2 1.6 2.0 2.4 2.8 3.1 3.4 3.7 4.0 4.3 4.6 4.9 5.2 5.5 5.8 6.1 6.4 6.7 7.0 7.3 7.6 8.0 8.3 8.6 8.9 9.2 9.5 9.8 10.1 10.4 10.7 11.0 11.3 11.6 11.9 12.2 12.5 12.8 13.1 13.4 13.7 14.0 14.3 14.6 14.9 15.2 15.5 15.8 16.1 16.4 16.7 17.0 17.3 17.6 17.9 18.2 18.5 18.8 19.1 19.4 19.7 20.0 20.3 20.6 20.9 21.2 21.5 21.8 22.1 22.4 22.7 23.0 23.3 23.6 23.9 24.2 24.5 24.8 25.1 25.4 25.7 26.0 26.3 26.6 26.9 27.2 27.5 27.8 28.1 28.4 28.7 29.0 29.3 29.6 29.9 30.2 30.5 30.8 31.1 31.4 31.7 32.0 32.3 32.6 32.9 33.2 33.5 33.8 34.1 34.4 34.7 35.0 35.3 35.6 35.9 36.2 36.5 36.8 37.1 37.4 37.7 38.0 38.3 38.6 38.9 39.2 39.5 39.8 40.1 40.4 40.7 41.0 41.3 41.6 41.9 42.2 42.5 42.8 43.1 43.4 43.7 44.0 44.3 44.6 44.9 45.2 45.5 45.8 46.1 46.4 46.7 47.0 47.3 47.6 47.9 48.2 48.5 48.8 49.1 49.4 49.7 50.0 50.3 50.6 50.9 51.2 51.5 51.8 52.1 52.4 52.7 53.0 53.3 53.6 53.9 54.2 54.5 54.8 55.1 55.4 55.7 56.0 56.3 56.6 56.9 57.2 57.5 57.8 58.1 58.4 58.7 59.0 59.3 59.6 59.9 60.2 60.5 60.8 61.1 61.4 61.7 62.0 62.3 62.6 62.9 63.2 63.5 63.8 64.1 64.4 64.7 65.0 65.3 65.6 65.9 66.2 66.5 66.8 67.1 67.4 67.7 68.0 68.3 68.6 68.9 69.2 69.5 69.8 70.1 70.4 70.7 71.0 71.3 71.6 71.9 72.2 72.5 72.8 73.1 73.4 73.7 74.0 74.3 74.6 74.9 75.2 75.5 75.8 76.1 76.4 76.7 77.0 77.3 77.6 77.9 78.2 78.5 78.8 79.1 79.4 79.7 80.0 80.3 80.6 80.9 81.2 81.5 81.8 82.1 82.4 82.7 83.0 83.3 83.6 83.9 84.2 84.5 84.8 85.1 85.4 85.7 86.0 86.3 86.6 86.9 87.2 87.5 87.8 88.1 88.4 88.7 89.0 89.3 89.6 89.9 90.2 90.5 90.8 91.1 91.4 91.7 92.0 92.3 92.6 92.9 93.2 93.5 93.8 94.1 94.4 94.7 95.0 95.3 95.6 95.9 96.2 96.5 96.8 97.1 97.4 97.7 98.0 98.3 98.6 98.9 99.2 99.5 99.8 100.0