LONG-TERM THERMOGRAPH RECORDS
FROM THE UPPER FLORIDA KEYS

Comparisons Between Sites

U. S. Geological Survey

Thermograph Sites
1. Snake Creek
2. Hen and Chickens
3. Crocker Reef (Crest)
4. Cement Dome Reef

Depth Contours in Feet

1 Current Affiliation: NOAA, Florida Keys National Marine Sanctuary

Open-File Report # 91-344

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.
This report consists of figures showing correlations of water temperature between four sites in the upper Florida Keys. Data are presented from the Hen and Chickens site from 1975-1987, Cement Dome and Snake Creek sites from 1977-1987 and from the Crocker Reef site from 1981-1987. Locations of the sites are shown on the cover illustration. Descriptions of the sites are found on the following pages. Hourly data were collected using General Oceanics\textsuperscript{1} model 3011 thermographs which were placed at sites for a maximum period of 120 days. Thermographs were calibrated at intervals of 120 days or less and record data to ±0.1 degree C. Data presented here are daily averages of the hourly measurements. Correlations are shown for each two sites as a second-order polynomial regression and as a time series of daily temperature for one year. Missing data is represented by straight lines on yearly temperature variation graphs. Missing data are omitted from regression graphs and calculations.

Acknowledgments - The authors would like to than the Caribbean Research Center for support to Donna Schroeder during early compilations of this data. Peter Spicer and Karen Higgins of the USGS graciously helped with the presentation format.

\textsuperscript{1}Use of brand names in this report is for descriptive purposes only and does not imply endorsement by the U. S. Geological Survey.
THERMOGRAPH STATIONS

STATION #1 - SNAKE CREEK

Location: 24° 57.1' N
80° 35.3' W

Station Site: Thermograph placed in shallow hole near mid-channel on ocean side of bridge. Unit partially hidden by loose rock slab with sensor exposed on channel bottom.

Setting: Tidal channel - Eroded into Key Largo Limestone, the channel floor is mostly bedrock with interspersed patches of sediment, algae and seagrass.

Water depth: 3.5 m

STATION #2 - HEN AND CHICKENS REEF

Location: 24° 56.0 N
80° 33.0 W

Station Site: Thermograph concealed in open-ended cavity within star coral (Montastrea annularis) 0.5m above seafloor

Setting: Inshore patch reef - A mature patch reef dominated by the star coral with colonies up to 3m high on level rock substrate. Reef area surrounded by generally thin sediment cover and seagrass.

Water Depth: 4 m

STATION #3 - CROCKER REEF

Location: 24° 54.4' N
80° 35.5' W

Station Site: Thermograph concealed under rock outcrop so that sensor is exposed at seafloor

Setting: Low-profile, relict bank on outer edge of reef tract. Rocky surface populated with sea fans (Gorgonia ventalina) and other soft coral species with scattered, small colonies if hard corals (including Dichocoenia stokesii and Meandrina meandrities).

Water Depth: 5 m
STATION #4 - CEMENT DOME

Location:  $25^\circ$ 27.8' N  
          $82^\circ$ 10.0' W

Station Site: The thermograph is concealed beneath a 1m diameter artificial coral head. Sensor on seafloor near one of several openings at base of artificial coral head.

Setting: An artificial patch reef constructed from cement domes appearing as coral heads and seeded with transplanted stony and soft corals. Patch is situated on a rock bottom naturally populated by gorgonians and alcionarians.

Depth: 4.0m

Graph Index

<table>
<thead>
<tr>
<th>Graph Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hen and Chickens Temperatures 1975-76</td>
<td>1</td>
</tr>
<tr>
<td>Snake Creek vs Hen and Chickens 1977-1987</td>
<td>3</td>
</tr>
<tr>
<td>Cement Dome vs. Hen and Chickens 1977-1987</td>
<td>25</td>
</tr>
<tr>
<td>Snake Creek vs Cement Dome 1977-1987</td>
<td>47</td>
</tr>
<tr>
<td>Hen and Chickens vs Crocker Crest 1981-1987</td>
<td>69</td>
</tr>
<tr>
<td>Snake Creek vs Crocker Crest 1981-1987</td>
<td>83</td>
</tr>
<tr>
<td>Cement Dome vs Crocker Crest 1981-1987</td>
<td>97</td>
</tr>
</tbody>
</table>
Snake Creek and Hen & Chickens 1977

Sea Water Temperature (°C)

Month

SC1977
HC1977
Snake Creek and Hen & Chickens 1978

Sea Water Temperature (°C)

Month

SC1978

HC1978
Snake Creek

Sea Water Temperature (°C) 1980

Hen and Chickens

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>0.976</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0.261</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>12.512</td>
<td></td>
</tr>
</tbody>
</table>

y = c + bx + ax^2
Snake Creek and Hen & Chickens 1981

Sea Water Temperature (°C)

Month

- SC1981
- HC1981
Snake Creek and Hen & Chickens 1982

Sea Water Temperature (°C)

Month

SC1982
HC1982
Snake Creek and Hen & Chickens 1983

Sea Water Temperature (°C)

Month

- SC1983
- HC1983
Snake Creek and Hen & Chickens 1984

Sea Water Temperature (°C)

Month

J F M A M J J A S O N D

SC1984

HC1984
Snake Creek and Hen & Chickens 1987

Sea Water Temperature (°C)

Month

SC1987

HC1987
Cement Dome and Hen & Chickens 1977

Sea Water Temperature (°C)

Month
Sea Water Temperature (°C) 1977

Hen and Chickens

Cement Dome

Sea Water Temperature (°C) 1977
Cement Dome and Hen & Chickens 1979

Sea Water Temperature (°C)

Month

CD1979
HC1979
Cement Dome and Hen & Chickens 1981

Sea Water Temperature (°C)

Month

CD1981

HC1981
Sea Water Temperature (°C) 1982

Cement Dome

<table>
<thead>
<tr>
<th>1</th>
<th>0.984</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-0.010</td>
</tr>
<tr>
<td>B</td>
<td>1.363</td>
</tr>
<tr>
<td>C</td>
<td>1.843</td>
</tr>
</tbody>
</table>

y = C + Bx + Ax^2
Cement Dome and Hen & Chickens 1983

Sea Water Temperature (°C)

Month

J F M A M J J A S O N D

CD1983
HC1983
Cement Dome and Hen & Chickens 1984

Sea Water Temperature (°C)

Month

CD1984
HC1984
Hen and Chickens

Sea Water Temperature (°C) 1984

Cement Dome

\[ y = C + Bx + Ax^2 \]

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>-0.009</td>
<td>1.333</td>
<td>2.227</td>
</tr>
</tbody>
</table>

0.981
### Sea Water Temperature (°C) 1985

<table>
<thead>
<tr>
<th>Y = C + Bx + Ax²</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.006</td>
</tr>
<tr>
<td>B</td>
<td>0.471</td>
</tr>
<tr>
<td>C</td>
<td>10.536</td>
</tr>
<tr>
<td>r</td>
<td>0.919</td>
</tr>
</tbody>
</table>

**Legend:**
- Sea Water Temperature (°C) 1985
- Hen and Chickens
- Cement Dome
Cement Dome and Hen & Chickens 1986

Sea Water Temperature (°C)

Month

CD1986
HC1986
Sea Water Temperature (°C) 1986

Hen and Chickens

Cement Dome

\[ y = C + Bx + Ax^2 \]

\[ A = -0.020 \]

\[ B = 19.488 \]

\[ C = 0.968 \]

\[ r = 0.998 \]
Cement Dome and Hen & Chickens 1987

Sea Water Temperature (°C)

Month

CD1987
HC1987
Snake Creek and Cement Dome 1977

Sea Water Temperature (°C)

Month

SC1977
CD1977
Snake Creek and Cement Dome 1979

Sea Water Temperature (°C)

Month

SC1979

CD1979
Sea Water Temperature (°C) 1979

y = C + Bx + Ax^2

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>B</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11.231</td>
<td>1.771</td>
<td>-0.012</td>
</tr>
</tbody>
</table>

r = 0.970
Snake Creek and Cement Dome 1980

Sea Water Temperature (°C)

Month

- SC1980
- CD1980
Snake Creek and Cement Dome 1981

Sea Water Temperature (°C)

Month

- SC1981
- CD1981
The diagram shows a scatter plot with the relationship between Sea Water Temperature (°C) and another variable, possibly related to Cement Dome or Snake Creek. The plotted data points form a linear trend, indicating a strong correlation. The equation for the trend line is given as:

\[ y = C + Bx + Ax^2 \]

The coefficients for this equation are:

- \( C = 19.508 \)
- \( B = 2.413 \)
- \( A = 0.025 \)

The correlation coefficient \( r \) is 0.982, indicating a very strong positive correlation.
Sea Water Temperature (°C)

Snake Creek and Cement Dome 1986

Sea Water Temperature (°C)

Month

SC1986
CD1986
Sea Water Temperature (°C) 1986

Cement Dome

\[ y = C + Bx + Ax^2 \]

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>889.300</td>
</tr>
<tr>
<td>2</td>
<td>-57.712</td>
</tr>
<tr>
<td>3</td>
<td>0.968</td>
</tr>
<tr>
<td>4</td>
<td>0.806</td>
</tr>
</tbody>
</table>

Snake Creek
Sea Water Temperature (°C) 1987

Snake Creek

Cement Dome

Y = C + Bx + Ax^2

<table>
<thead>
<tr>
<th>r</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.987</td>
<td>-16.107</td>
<td>2.045</td>
<td>-0.016</td>
</tr>
</tbody>
</table>
Hen & Chickens and Crocker Crest 1981

Sea Water Temperature (°C)

Month

J F M A M J J A S O N D

HC1981
CC1981

69
Hen and Chickens

Sea Water Temperature (°C) 1981

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>0.971</td>
<td>1.265</td>
<td>-12.794</td>
</tr>
</tbody>
</table>

y = C + Bx + Ax^2
Hen and Chickens

Sea Water Temperature (°C) 1982

\[ y = C + Bx + Ax^2 \]
Sea Water Temperature (°C)

Hen & Chickens and Crocker Crest 1984

Sea Water Temperature (°C)

Month

- HC1984
- CC1984
Sea Water Temperature (°C) 1984

\[ y = C + Bx + Ax^2 \]

\begin{array}{|c|c|}
\hline
r & 0.948 \\
A & -0.017 \\
B & 2.131 \\
C & -18.675 \\
\hline
\end{array}

Crocker Crest

Hen and Chickens

Sea Water Temperature (°C) 1984
Hen & Chickens and Crocker Crest 1985

Sea Water Temperature (°C)

Month

HC1985
CC1985
Hen & Chickens and Crocker Crest 1986

Sea Water Temperature (°C)

Month

HC1986
CC1986
Sea Water Temperature (°C)

Hen & Chickens and Crocker Crest 1987

Sea Water Temperature (°C)

- HC1987
- CC1987

Month
Hen and Chickens

Sea Water Temperature (°C) 1987

Y = C + Bx + Ax^2

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-111.704</td>
<td>9.289</td>
<td>-0.152</td>
<td>0.991</td>
</tr>
</tbody>
</table>
Sea Water Temperature (°C)

Snake Creek and Crocker Crest 1981

Sea Water Temperature (°C)

Month

SC1981
CC1981
Snake Creek and Crocker Crest 1982

Sea Water Temperature (°C)

Month

SC1982
CC1982
Snake Creek and Crocker Crest 1984

Sea Water Temperature (°C)

Month

SC1984
CC1984
Sea Water Temperature (°C) 1986

Snake Creek

Crocker Crest

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>96.925</td>
<td>0.154</td>
<td>-6.851</td>
<td>0.993</td>
</tr>
</tbody>
</table>
Sea Water Temperature (°C) 1987

y = C + Bx + Ax^2

<table>
<thead>
<tr>
<th>J</th>
<th>0.649</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.397</td>
</tr>
<tr>
<td>B</td>
<td>-16.433</td>
</tr>
<tr>
<td>C</td>
<td>187.853</td>
</tr>
</tbody>
</table>

Crocker Crest

Snake Creek
Cement Dome and Crocker Crest 1981

Sea Water Temperature (°C)

Month

CD1981
CC1981
Sea Water Temperature (°C) 1981

y = C + Bx + Ax^2

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.018</td>
<td>2.155</td>
<td>-18.795</td>
<td>0.872</td>
</tr>
</tbody>
</table>
Sea Water Temperature (°C) 1982

Crocker Crest

Cement Dome

\[ y = C + Bx + Ax^2 \]

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.060</td>
<td>0.2791</td>
<td>58.188</td>
</tr>
</tbody>
</table>

r = 0.930
Cement Dome and Crocker Crest 1983

Sea Water Temperature (°C)

Month

CD1983
CC1983
Sea Water Temperature (°C) 1983

<table>
<thead>
<tr>
<th>C</th>
<th>B</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.245</td>
<td>-0.420</td>
<td>0.023</td>
</tr>
</tbody>
</table>

\[ y = C + Bx + Ax^2 \]

Coveker Crest
Sea Water Temperature (°C) 1984

Cement Dome

Crocker Crest

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.953</td>
<td>0.024</td>
<td>-0.588</td>
<td>25.72</td>
<td>( y = c + bx + ax^2 )</td>
</tr>
</tbody>
</table>
Cement Dome

Sea Water Temperature (°C) 1986

y = C + Bx + Ax²

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.958</td>
</tr>
<tr>
<td>A</td>
<td>0.035</td>
</tr>
<tr>
<td>B</td>
<td>-1.280</td>
</tr>
<tr>
<td>C</td>
<td>34.543</td>
</tr>
</tbody>
</table>

Crocker Crest
Cement Dome and Crocker Crest 1987

Sea Water Temperature (°C)

Month

CD1987
CC1987