

Supplementary Materials for

Ghost reefs: Nautical charts document large spatial scale of coral reef loss over 240 years

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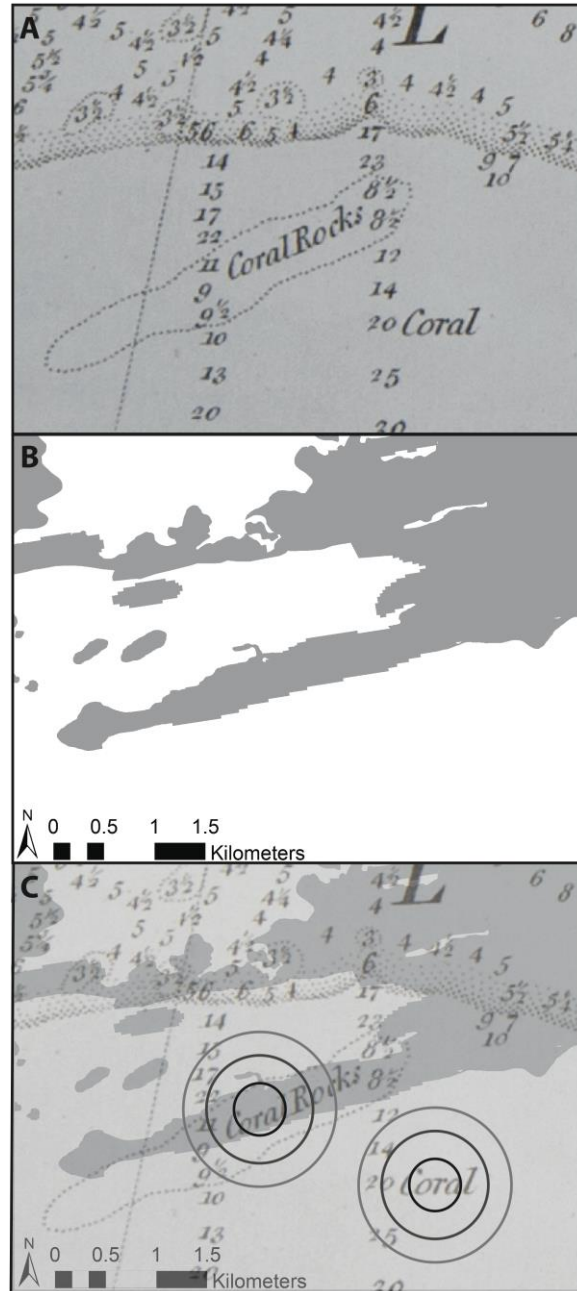


fig. S1. Example of method used to estimate coral persistence. (A). Example of historical coral observations. (B) Modern coral data (light gray) for the same area, representing a combination of the three layers. (C). Overlaid maps three threshold distances used to estimate probability of persistence. Inner black circle = 0.25 km; middle gray circle = 0.5 km; outer gray circle = 0.75km. For the observation of “coral rocks,” modern coral was present within all three threshold distances, while in the observation of “coral” it was not present within any of these distances. The two maps demonstrate striking similarity, though the overlay exemplifies the level of misalignment possible between the two datasets.

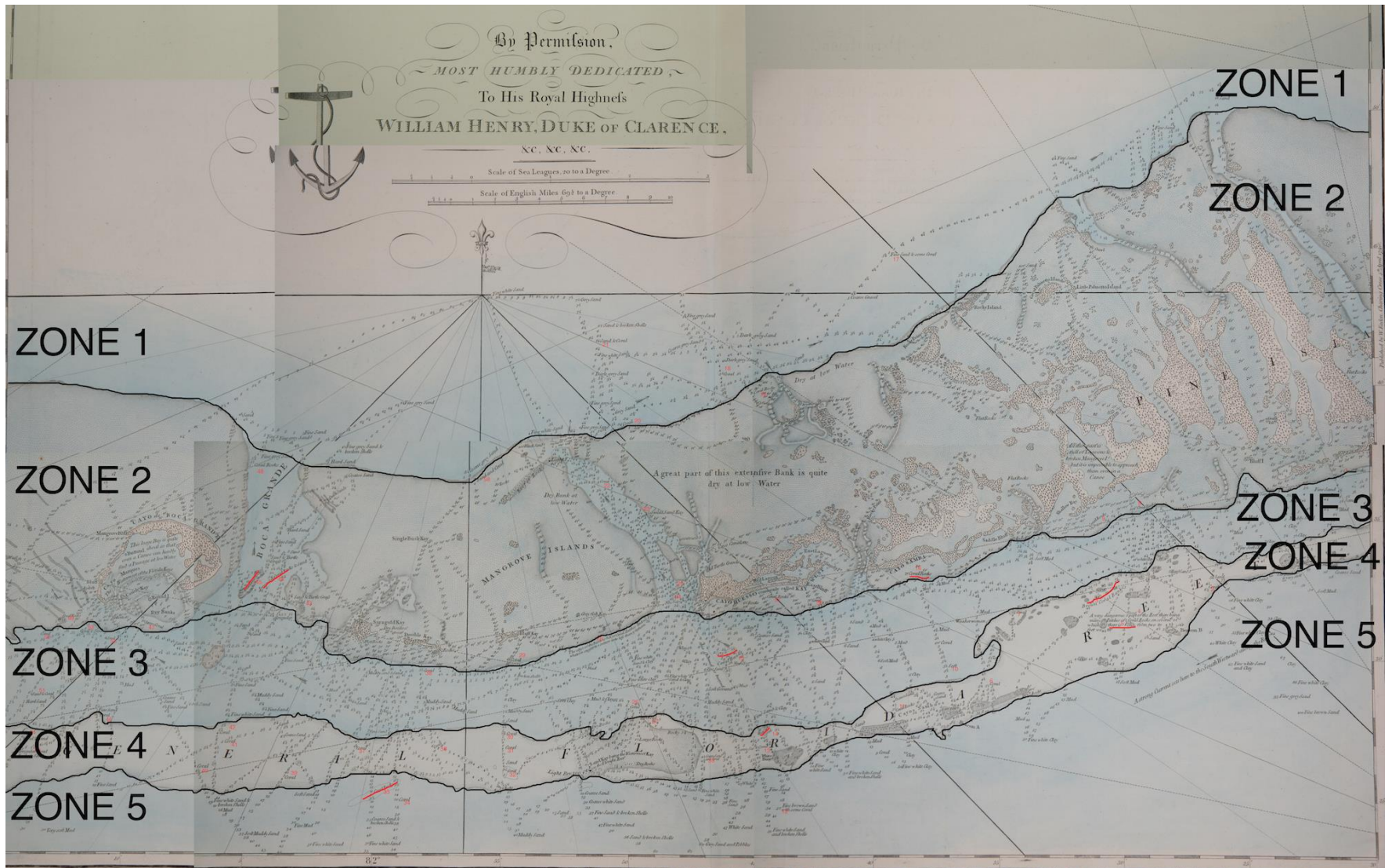


fig. S2. Historical coral maps and zones and all historical coral observations (see table S2 for the additional data on each coral observation). Sepia tone: Gauld (1775), Upper Keys; Color map: Gauld (1774), Lower Keys.

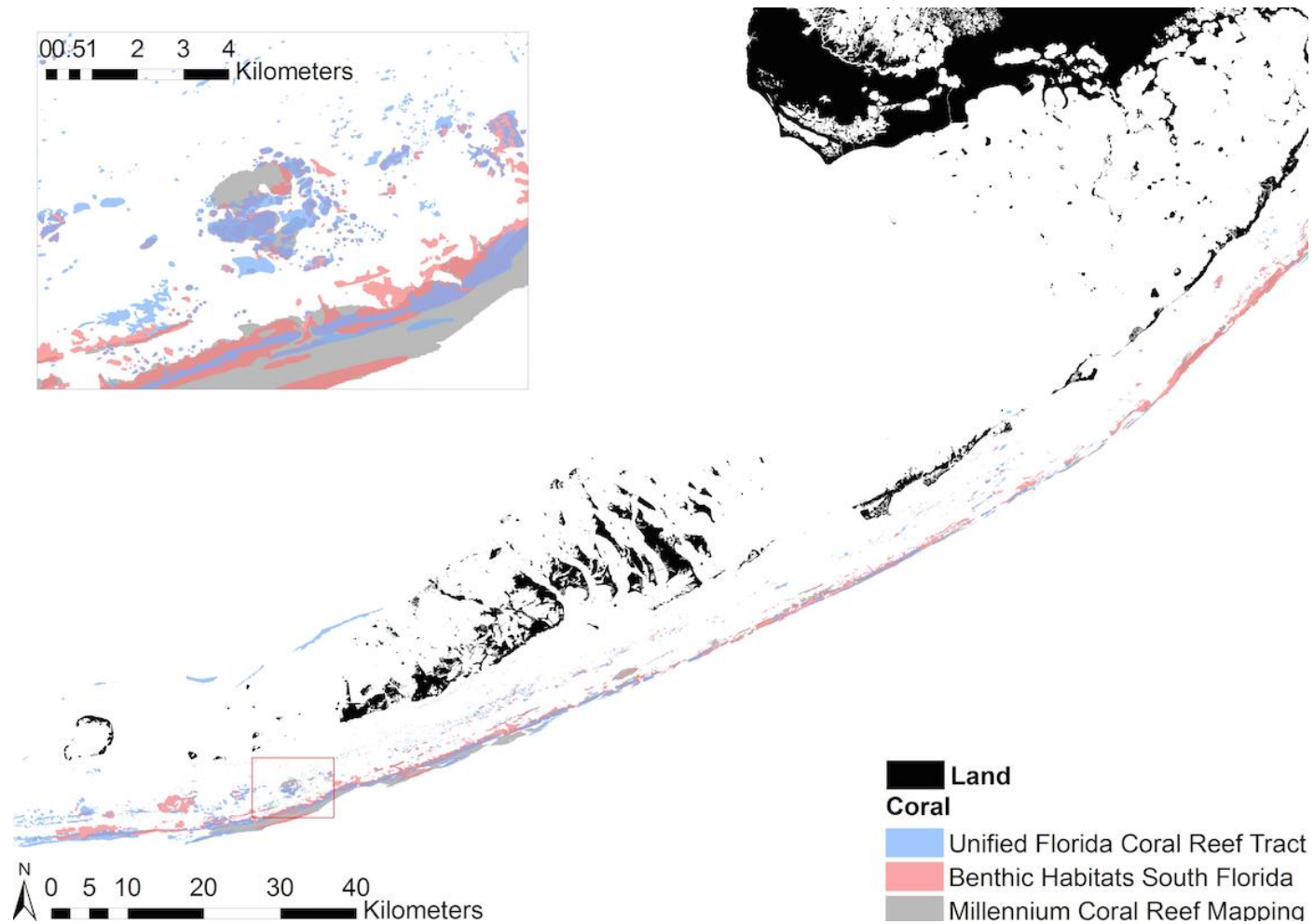


fig. S3. The three modern coral data layers showing the differences and overlaps among them. (1) the Millennium Coral Reef Mapping Project, which identifies area of coral reef using high resolution remote sensing images, (3) the Benthic Habitats South Florida Map, which delineates benthic habitat from 1:48,000 scale aerial photographs, and (2) the Unified Florida Coral Reef Tract Map, which combines imagery, in situ observations, and bathymetric data. Our modern data layer is a combination of the coral represented in these three maps.

table S1. Descriptive data from Gauld (1790) and the text box on the chart (fig. S1).

Reef description	Depth (Location)	Zone
The Reef from Cayo Sombrero is in general very broken ground as far as the west end of Matacumbe; there being patches of coral rocks, with six and eight feet water;	1.8-2.4m (Sombrero Key to Matacumbe Key)	4
...and others where the rocks rise to the surface, particularly some spot off the east end of Cayo Vaccas, about seven or eight miles offshore.	0m (Boot Key)	3
There are likewise some large patches of eight or nine feet off the middle of Kay Bivoras...	2.4-2.7m (Long Key)	2
...and another large rocky shoal of eight and ten feet off the west end of Matacumbe.	2.4-3.0m (Matacumbe Key)	2
Reef comes within less than three miles of Rodrigues. From large shoal off Rodrigues, which forms a kind of elbow, the patches of Coral Rocks are said to increase in number and dimensions, forming several Reefs, with small Channels of deep water through them.	nd (Rodriguez Key)	Outside map extent
[T]here are two or three patches of Coral rocks with two and a half and three fathoms water, nearly in mid channel, lying about S.S.E. from the west end of Cayo Huesso.	4.6-5.5m (Key West)	3
...for ten miles to the eastward of these Kays, the Reef is broad and dangerous, there being in some places dry rocks.	0m (Boca Chica)	2
Bahia Honda [channel] has a good deal of small coral (noted for ease of anchoring, especially for long stays)	nd (Bahia Honda)	2
About four leagues to the Eastward of Cayo Sombrero there are some dry Patches of Coral Rocks.	0m (Sombrero Key)	4
SE direction from west end of Kay Vacas there is a large Bank of Coral Rocks.	nd (Boot Key)	3
...small Bank [of coral] abreast of Kay Bivoras	nd (Long Key)	2
There is a large Bank of Coral with 8&10 feet, lying due south 4 1/2 miles from west end of Old Matacumbe.	2.4-3.0m (Lower Matacumbe Key)	3
Large rocky shoal almost dry bearing SSE 4 miles from the west end of New Matacumbe.	0m (Upper Matacumbe Key)	4

table S2. All historical data, with coral observation number, map (Lower Keys versus Upper Keys), depth in meters, reef zone, and distance to nearest modern coral. (See fig. S2 for locations of each coral observation).

Coral Observation Number	Map	Depth(m)	Reef Zone	Distance to Millennium (km)	Distance to Benthic Habitat (km)	Distance to Unified Reef (km)
1	Upper Keys	5.03	3	3.25	0.74	0.69
2	Upper Keys	5.49	3	3.02	1.07	0.78
3	Upper Keys	5.49	3	2.04	1.67	1.32
4	Upper Keys	31.09	5	0.72	0.91	0.45
5	Upper Keys	3.66	3	5.32	1.55	2.14
6	Upper Keys	3.66	4	1.49	0	0.95
7	Upper Keys	23.77	5	1.66	1.77	2.53
8	Upper Keys	8.69	4	0	0	0.75
9	Upper Keys	29.26	5	0.98	0.8	1.5
10	Upper Keys	34.75	5	1.82	1.62	2.28
11	Upper Keys	45.72	5	2.22	2.13	2.76
12	Upper Keys	29.26	5	1.16	1.08	1.74
13	Upper Keys	12.80	5	0	0	1.11
14	Upper Keys	8.23	4	0	0	0.99
15	Upper Keys	6.40	3	2.87	1.56	1.56
16	Upper Keys	6.40	4	2.05	1.29	3.38
17	Upper Keys	27.43	5	0	0	3.29
18	Upper Keys	5.49	4	1.11	1.35	1.92
19	Upper Keys	4.57	3	5.36	1.96	1.84
20	Upper Keys	4.11	3	4.12	1.9	2.89
21	Upper Keys	8.23	4	1.48	0.08	0.43
22	Upper Keys	8.69	4	1.02	0.39	0.48
23	Upper Keys	21.95	5	1.51	1.38	1.41
24	Upper Keys	7.32	3	3.41	1.78	1.78
25	Upper Keys	8.23	3	1.79	0.99	1.48
26	Upper Keys	8.23	4	0.71	0.31	0.43
27	Upper Keys	8.69	4	0.32	0.59	0.21
28	Upper Keys	8.69	3	2.63	0.31	0.32
29	Upper Keys	31.09	5	1.23	1.66	1.2
30	Upper Keys	42.06	5	2.14	2.5	2.09
31	Upper Keys	21.95	5	0.91	1.13	0.78
32	Upper Keys	7.32	4	1.44	0.25	0.99
33	Upper Keys	10.06	3	2.49	1.34	1.8
34	Upper Keys	8.23	3	3.99	2.59	0.48
35	Upper Keys	4.11	2	8.11	4.55	3.47
36	Upper Keys	3.66	3	3.6	1.33	0.16
37	Upper Keys	4.11	3	0	0	0

38	Upper Keys	5.49	3	0	0	0
39	Upper Keys	7.32	3	0.58	0.41	0.41
40	Upper Keys	5.49	4	0.8	0	0.35
41	Upper Keys	8.23	4	0	0	0
42	Upper Keys	12.80	5	0.4	0.7	0.48
43	Upper Keys	5.94	3	0.41	0.36	0.36
44	Upper Keys	4.57	4	0.69	0.19	0.35
45	Upper Keys	18.29	5	0.23	0.51	0.39
46	Upper Keys	5.49	4	0.4	0	0
47	Upper Keys	4.57	4	0.69	0.06	0.46
48	Upper Keys	4.57	3	1.5	0.44	1.37
49	Upper Keys	6.40	4	0	0.06	0.49
50	Upper Keys	38.40	5	1.81	1.96	2
51	Upper Keys	5.49	4	0.83	0.08	0.64
52	Upper Keys	10.52	3	1.34	1.2	0.37
53	Upper Keys	7.32	3	0.65	0.59	0.2
54	Upper Keys	5.49	3	0.28	0.05	0
55	Upper Keys	0.61	3	2.06	0.67	0.48
56	Upper Keys	4.11	3	2.16	2.1	0.45
57	Upper Keys	4.57	4	0.39	0	0
58	Upper Keys	20.12	5	0.94	0.89	1.02
59	Upper Keys	29.26	5	1.21	1.32	1.39
60	Upper Keys	32.92	5	1.74	1.9	1.93
61	Upper Keys	36.58	5	1.37	1.64	1.44
62	Upper Keys	4.57	2	7.01	6.99	4.67
63	Upper Keys	2.44	1	11	10.09	9.47
64	Upper Keys	2.74	2	5.96	4.62	4.59
65	Upper Keys	0.61	2	6.53	4.45	4.66
66	Upper Keys	9.60	4	0.1	0	1.54
67	Upper Keys	8.23	4	0.2	0.97	0.82
68	Upper Keys	7.77	4	0.11	0	0.11
69	Upper Keys	10.06	4	0.39	0	0
70	Upper Keys	7.32	4	0	0	0
71	Upper Keys	5.49	3	1.86	0.15	0.15
72	Upper Keys	6.86	3	3.38	0.11	0.68
73	Upper Keys	1.83	2	5.82	2.76	3.23
74	Upper Keys	7.32	2	6.26	2.97	3.32
75	Upper Keys	5.94	2	7.74	4.03	4.04
76	Upper Keys	3.66	2	8.22	4.5	4.42
77	Upper Keys	4.11	2	9.13	5.39	5.31
78	Upper Keys	0.91	2	9.82	6.26	6.3
79	Upper Keys	5.49	3	4.82	2.27	2.05
80	Upper Keys	8.23	4	0.14	0.19	2.5

81	Upper Keys	2.44	2	8.33	5.11	5.66
82	Upper Keys	4.57	1	25.36	24.06	23.02
83	Upper Keys	3.05	1	11.64	7.14	6.94
84	Upper Keys	2.13	1	19.76	16.57	16.36
85	Upper Keys	7.32	4	1.2	0.26	0.79
1	Lower Keys	1.83	2	6.95	3.96	3.98
2	Lower Keys	8.23	4	0.18	0	0.31
3	Lower Keys	1.22	4	1.22	0.35	0.9
4	Lower Keys	10.97	4	0.23	0	0.12
5	Lower Keys	5.49	4	0.11	0.1	0.1
6	Lower Keys	6.40	4	0	0.77	0.77
7	Lower Keys	4.57	4	0.22	0.07	0.14
8	Lower Keys	3.05	2	8.28	3.68	2.49
9	Lower Keys	3.05	2	4.7	0.99	1.25
10	Lower Keys	3.66	3	0	0	0
11	Lower Keys	6.40	4	0.39	1.03	1.85
12	Lower Keys	58.52	5	6.26	6.45	6.61
13	Lower Keys	9.14	4	0.29	0.62	1.96
14	Lower Keys	9.14	4	0.29	0.28	0.83
15	Lower Keys	9.14	3	2.74	2.68	0.32
16	Lower Keys	2.13	2	6.62	0.18	0.27
17	Lower Keys	9.14	1	24.88	21.43	15.01
18	Lower Keys	6.40	1	21.5	19.29	1.35
19	Lower Keys	2.44	2	18.16	12.07	0.43
20	Lower Keys	5.94	1	22.07	18.88	1.18
21	Lower Keys	11.43	1	25.38	25.09	1.02
22	Lower Keys	9.14	2	13.76	12.9	0.63
23	Lower Keys	7.32	2	11.77	10.98	5.16
24	Lower Keys	7.32	2	7.27	4.77	3.82
25	Lower Keys	6.40	2	7.74	5.09	4.51
26	Lower Keys	10.97	3	3.28	0.62	0.7
27	Lower Keys	7.32	4	0	0	0.16
28	Lower Keys	5.49	2	4.18	2.34	0.49
29	Lower Keys	1.83	2	4.39	3.74	0.19
30	Lower Keys	6.86	4	0.96	0	0.52
31	Lower Keys	10.97	4	0	0	0
32	Lower Keys	5.94	4	0	0.36	0.18
33	Lower Keys	8.23	4	0.21	0.51	1.41
34	Lower Keys	36.58	5	1.22	2.33	1.15
35	Lower Keys	20.12	5	0.22	1.29	0.19
36	Lower Keys	14.63	4	0.95	0.23	0.23
37	Lower Keys	8.69	4	1.1	0.88	0.97
38	Lower Keys	6.40	3	4.92	1.71	2.08

39	Lower Keys	9.14	4	0.48	0.25	0.62
40	Lower Keys	7.32	4	0	0	0
41	Lower Keys	9.14	4	0.91	0.2	0.57
42	Lower Keys	7.32	4	1.53	0.19	0.29
43	Lower Keys	2.74	2	7.55	6.58	5.15
44	Lower Keys	5.94	2	10.48	9.55	7.41
45	Lower Keys	3.05	2	10.88	9.4	4.98
46	Lower Keys	10.97	3	2.48	1.1	0
47	Lower Keys	2.59	2	9.15	0.98	1.13
48	Lower Keys	5.49	2	16.52	15.77	1.78
49	Lower Keys	1.83	2	10.43	5.08	1.14
50	Lower Keys	5.49	3	8.28	6.67	2.42
51	Lower Keys	12.34	3	4.21	3.58	0.33
52	Lower Keys	5.49	3	8.21	3.66	3.27
53	Lower Keys	7.32	3	8.34	2.54	4.11
54	Lower Keys	6.86	4	1.74	4.6	0.33
55	Lower Keys	10.97	4	0.73	5.11	0.2
56	Lower Keys	2.13	2	6.24	4.39	1.5
57	Lower Keys	1.83	2	6.28	4.17	0.32
58	Lower Keys	3.66	2	16.7	13.21	2.28
