Shell Debris and Shoreline Energy on Florida Gulf Beaches

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During the last 50 years several systems of coastal classification have been proposed. Johnson (1919, *fide* Shepard 1963) classified coasts as submergent, emergent, neutral, or compound. Shepard (1963) classified coastal areas by the agents acting upon them: Primary coasts being those acted upon by terrestrial agents, and secondary coasts those under the influence of marine processes. Price (1953, fide Tanner 1960), characterized Florida's coastal environments by energy levels, using ramp angles as a first approximation. Tanner (1960) classified Florida's coastal regions according to their respective energy levels. He approximated energy levels by using Helle's (1958) surf statistics and interpolating between points of observation. This treatment divides coasts into zero, low, moderate, and high energy environments.

The zero energy environment, as defined by Tanner, is characterized by mud, marsh grass, and no turbulence. A low energy

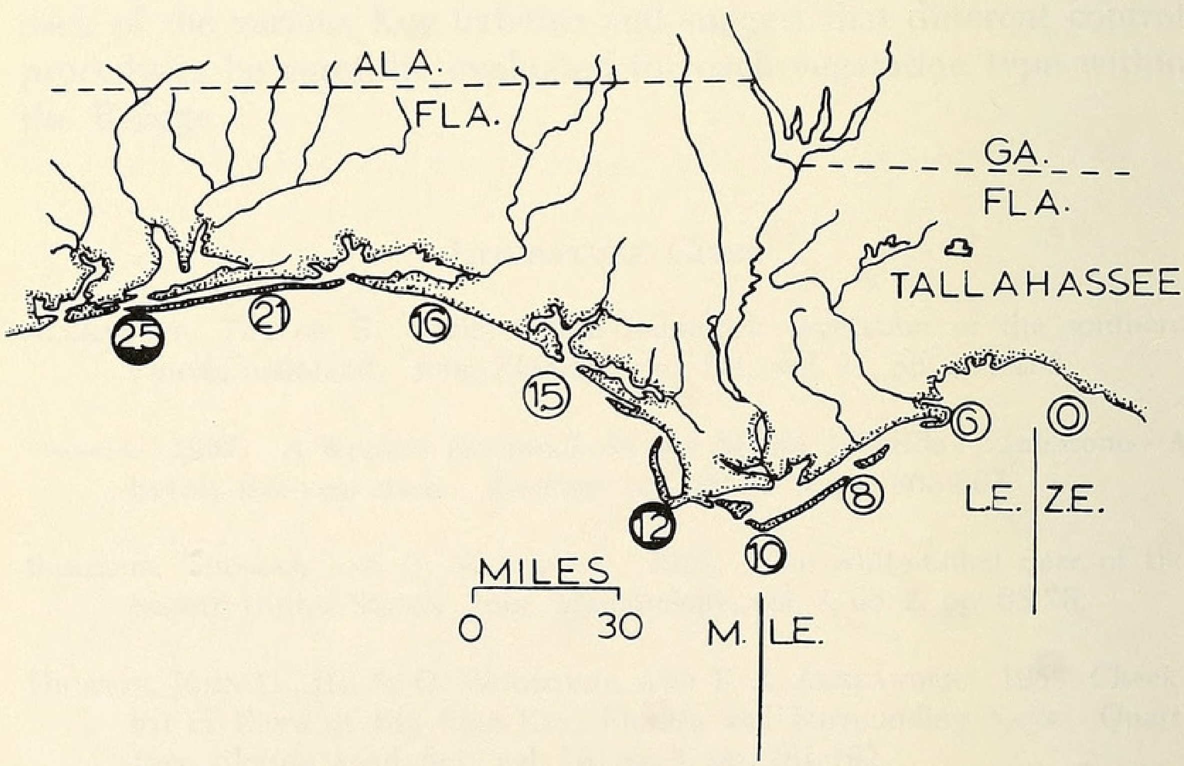

Fig. 1. Variations in energy levels along the Florida Panhandle coast (see text for discussion of symbols). Adapted from Tanner (1960). M, moderate; LE, low energy; ZE, zero energy.

beach has average annual breaker heights up to 10 cm, followed by the moderate energy environment with an average breaker height of 10-50 cm. The high energy environment experiences average breaker heights of over 50 cm.

Visual observations at a given time are often not sufficient to estimate the energy level on a specific beach, although one can usually differentiate between a zero-energy and a high-energy beach. Low to moderate energy shores grade into each other, however, and are hard to differentiate. It is equally difficult to assign a qualitative energy value to a beach. Energy expended on a beach reduces the size of certain organic materials such as molluscan shells and shell debris. Therefore, the size of the shell debris, other factors being equal, should be an indicator of relative energy levels.

This paper is a description of a technique by which the energy level and average breaker height may be estimated by study of the unconsolidated shoreline substrate material and provides an alternate, but complementary method to that developed by Tanner (1960), for estimating relative energy levels.

PROCEDURES

A sample of the substrate from the high tide swash mark was collected at each of the locations in Table 1. This sample was fractioned by sieving under running water.

The fractions were separated by 5 mm groupings: 1-5, millimeters, 6-10, 11-15, and so on. Each fraction was weighed and the modal size class was established by the weight percentage. The modal classes were correlated geographically, and the energy levels as established by Tanner (1960). A multiple-variance regression analysis was carried out at the Florida State Computer Center using stepwise regression (Dixon, 1968). The correlation coefficient was determined for the modal size of shell hash debris versus energy, and longitude.

RESULTS

Table 1 lists the modal frequency distribution of shell and shell-hash sizes from the collection sites. When possible, collections were made at the locations where Tanner had established energy values. These values are shown when applicable.

TABLE 1

Collection data

Collection sites	Values*	Size†	Longitude
1. Dekel Beach	0	36–40mm	83°49′W
2. Shell Point	not available	31–35mm	84°18′W
3. Alligator point	6	16–20mm	84°22′W
4. Central street St. Georges Isl.	not available	6–10mm	84°51′W
5. Cape San Blas	12	1–5 mm	85°23′W
6. Mexico Beach	not available	1–2 mm	85°25′W
7. West Panama City Beach	15	6–10mm	85°55′W

*Average annual breaker height, after Tanner (1960).
†Hash, modal size

Figure 2 is a graphic representation of the modal frequencies plotted against Tanner's energy levels. With the exception of Panama City Beach the average shell-fragment size decreased as the energy increased. The computed correlation coefficient was −0.925 which indicates that a significant inverse relation exists between hash size and energy at the 99 per cent confidence interval. As the energy level increases, shell fragments show a correlated decrease in size. The correlation coefficient (−.867) between shell size and longitude also shows an inverse relationship at the 99 per cent confidence level.

Figure 3 shows the relation between shell size and longitude. Two breaks may be noted in the slope of the curve, one at Alligator Point, and the other at Cape San Blas.

DISCUSSION

Linear extrapolation between two points of measured physical parameters is at best an inprecise method for predicting average conditions of sea state. The prediction of average breaker heights by extrapolation between two points of measurement, over 100 miles apart, does not show possible rapid changes that may occur between the points. The studies of Tanner, discussed above, involved such interpolations and may in theory have inaccuracies. The data presented here, however, indicate that his conclusions may have more validity than would be predicted.

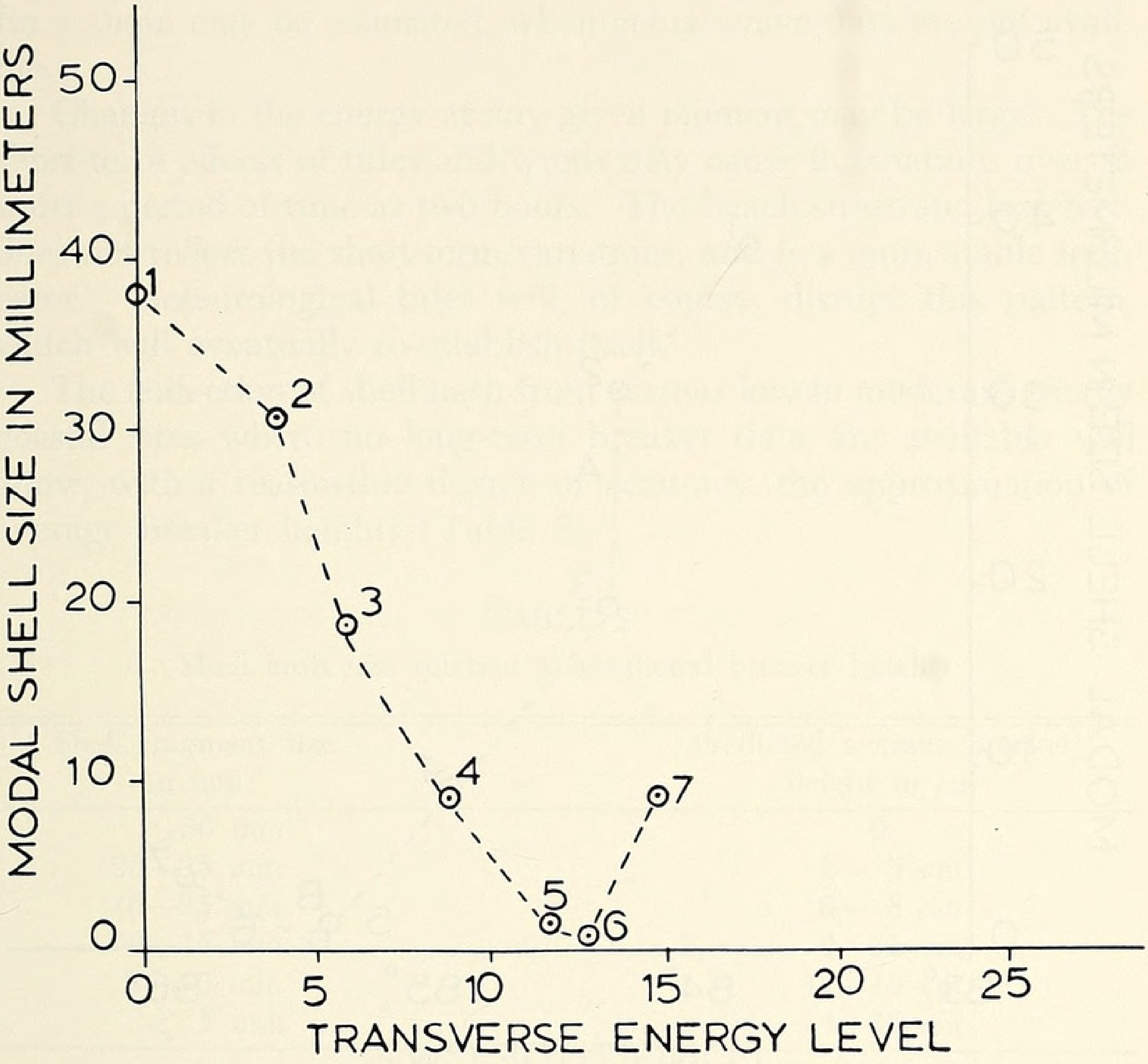

Fig. 2. Relation between modal shell size and Tanner's energy levels (see Table 1 for numbered locations).

The decrease in shell-hash size is inversely correlated to increase in breaker height. From zero, through the lower half of the moderate energy environment, the coasts exhibit large offshore infaunal pelecypod populations, characterized by oysters (zero-energy environment) *Crassostrea sp.*, and cockels (low to moderate environment) *Dynocardium sp.* The higher level, moderate energy to high energy beaches, are in turn, typified by different benthonic population assemblages. The predominant pelecypod there is *Donax sp.* which lives in the turbulent zone and whose shells constitute the major percentage of the carbonate fraction of the beach substrate. On a higher energy beach the source of the shell material is within the zone of deposition, whereas in lower energy environments the shell source is offshore from the zone of deposition.

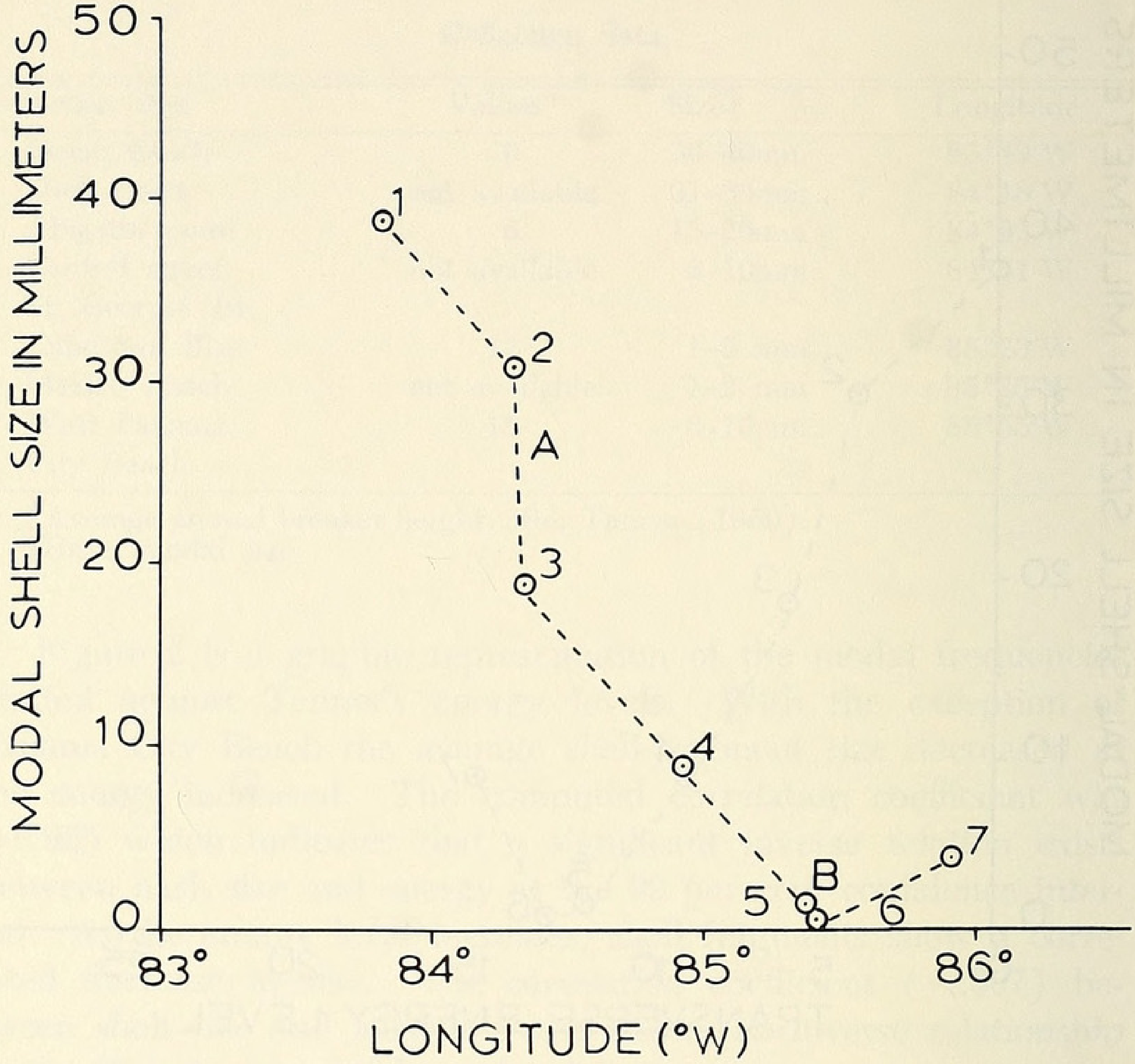

Fig. 3. Relation between modal shell hash and longitude (see Table 1 for numbered locations).

Figure 3 shows two breaks in the slope of the line, both of which occur along spits. Break *A* is at Alligator Point, and *B* at Cape San Blas. This indicates the non-linearity of the increasing wave energy, and the importance of spits, in terms of focusing energy upon small areas of shoreline.

CONCLUSIONS

The linear extrapolation of natural phenomena between widely spaced coastal points of measurements may be inaccurate due to topographic anomalies. The sampling of a form of semi-permanent feature may alleviate this inaccuracy. The use of shell debris from the high tide swash mark, along zero through moderate-energy coasts, is a potential technique by which the average breaker height for a shore may be estimated, when actual wave data are not available.

Changes in the energy at any given moment may be large. The short-term effects of tides and winds may cause fluctuations over so short a period of time as two hours. The beach substrate, however, does not reflect the short-term variations, and is a more stable indicator. Meteorological tides will, of course, disrupt this pattern, which will eventually re-establish itself.

The collection of shell hash from various low to moderate energy coastal sites where no long-term breaker data are available will allow, with a reasonable degree of accuracy, the approximation of average breaker heights (Table 2).

TABLE 2

Shell hash size relation to predicted breaker height

Shell fragment size in mm	Predicted average breaker height in cm
>36 mm	0
26—35 mm	1— 5 cm
16—25 mm	6— 8 cm
6—15 mm	9—11 cm
1— 5 mm	12—13 cm
< 1 mm	14—15 cm

LITERATURE CITED

DIXON, W. J. 1968. Biomedical computer programs. Univ. of California Press, Berkeley, California, 600 pp.

HELLE, J. R. 1958. Surf statistics for the coasts of the United States. Beach Erosion Board Technical Memorandum, no. 108.

JOHNSON, D. W. 1919. Shore processes of shoreline development. John Wiley & Sons, New York, 584 pp.

PRICE, W. A. 1953. The low energy coast and its new shoreline types of the Gulf of Mexico. IV Congresi de l'Association Internationale pour l' Etude du Quaternaire (INQUA). Paris, Project 63.

SHEPARD, F. 1963. Submarine Geology. 2nd edition, Harper & Row. New York. 557 pp.

Tanner, W. 1960. Florida coastal classification. Trans. Gulf Coast Assoc. Geol. Soc., vol. 10, pp. 259-266.

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