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USEABLE MEAT YIELDS IN THE VIRGINIA SURF CLAM FISHERY[1]

The weight of surf clam meat landed in Virginia is estimated by the National Marine Fisheries Service, Division of Statistics and Market News (DSMN) by multiplying bushels landed by a constant of 17 lb (7.71 kg) of total meat per bushel. However, total meat weight includes the viscera, a portion of clam not utilized by the industry. Herein is an analysis of the yield of useable surf clam meat weight per bushel and seasonal variability in meat weight relative to seawater temperature for Virginia stocks.

Methods

Monthly mean useable meat weight per bushel (MMUWB) was estimated from 181 daily landings totaling 167,564 bushels in 1974, and 160 daily landings totaling 270,170 bushels in 1975. The surf clams were harvested from Virginia stocks in the region offshore of Cape Henry and south to about False Cape.

Meat weight landings reported by DSMN are in pounds, for conformity useable meat weight estimates are also cited in pounds.

Monthly mean seawater temperature (MMST) was estimated from daily surface water temperatures recorded at Kiptopeke Beach, Va. (lat. 37°10.0′N, long. 75°59.3′W), about 13 n.mi. north of Cape Henry. These data, collected and published by National Oceanic and Atmospheric Administration (NOAA), Oceanographic Surveys Branch, exhibited seasonal trends which were correlated to changes in useable meat yield per bushel. Although these temperatures are not in situ measurements, they are a convenient covariate of meat yield.

The relationship of MMUWB to MMST was estimated by Model II regression analysis since both variables were subject to sampling error. The choice of a particular Model II analysis relative to the source of the variability (measurement errors, inherent variability, or both) is a somewhat unsettled subject recently discussed by Moran (1971), Ricker (1973, 1975) and Jolicoeur (1975). No such theoretical considerations were used in the present analyses. Four models were employed to derive "predictive" equations from the 1974 data: Ricker's (1973) geometric mean analysis (GM regression); Wald's (1940) and Bartlett's (1949) arithmetic mean analysis (termed AM regression by Ricker); and principal axis analysis (although it is recognized that variables do not truly have a bivariate normal association). Empirically, the adequacy of the models in predicting the observed 1975 annual mean useable meat weight per bushel (AMUWB) from the MMST in 1975 was assessed by a randomized block (two-way) analysis of variance in which the predicted and observed MMUWB were the experimental units replicated by months. MMST was recorded to 0.1°C, MMUWB to 0.01 lb.

Results and Discussion

The MMUWB of surf clams ranged from 10.8 to 14.0 lb in 1974, and from 10.6 to 14.5 lb in 1975 (Table 1). AMUWB, 12.5 lb in 1974 and 12.6 lb in 1975, were nearly identical ($P>0.80$). There was a cyclical increase in the MMUWB from the minima in winter months to maxima in July and August 1974 and in July 1975. The correlation coefficients (r) for MMUWB and MMST were 0.64 and 0.79 in 1974 and 1975, respectively; $r = 0.71$ for the pooled data.

The sinusoidal trend in MMUWB is probably related to maturation and subsequent spawning. Ropes (1968) reported a major spawning period in summer and a minor period in fall in New Jersey waters, but the time and duration of surf clam spawning in Virginia waters has not been reported. If increasing MMUWB is indicative of maturation, the data imply that most spawning by

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TABLE 1.—Number of bushels of surf clams processed, mean weight (pounds) of useable meats per bushel, and mean surface seawater temperature at Kiptopeke Beach by months in 1974 and 1975.

Month	Number of bushels		Mean useable meat/bushel		Mean seawater temperature (°C)	
	1974	1975	1974	1975	1974	1975
Jan.	19,736	18,225	11.7	10.6	6.7	5.9
Feb.	11,791	18,489	12.3	11.3	5.6	5.7
Mar.	13,450	8,237	12.3	12.7	8.4	6.7
Apr.	14,415	23,725	13.3	13.2	12.2	9.8
May	19,020	39,130	13.8	12.9	17.6	17.1
June	12,981	30,049	13.9	13.7	21.7	22.5
July	8,328	19,488	14.0	14.5	24.8	24.6
Aug.	10,140	23,930	14.0	13.7	25.0	26.6
Sept.	14,430	23,038	12.0	13.2	22.9	23.2
Oct.	14,558	29,136	11.4	12.4	16.2	19.5
Nov.	13,388	8,407	10.8	11.8	12.2	14.0
Dec.	15,327	28,316	10.8	11.1	6.8	7.6
Total	167,564	270,170				
Annual mean yield/bushel			12.52	12.59		

TABLE 2.—Mean monthly useable meat weight (pounds) per bushel for Virginia surf clams in 1975 estimates by four regression models.

Month	AM (Wald)	AM (Bartlett)	GM (Ricker)	Principal axis
Jan.	10.7	11.6	11	11.5
Feb.	10.7	11.6	11	11.5
Mar.	10.8	11.7	11.1	11.6
Apr.	11.1	12.0	11.6	12.0
May	11.8	12.7	12.9	12.8
June	12.4	13.3	13.8	13.3
July	12.6	13.5	14.1	13.6
Aug.	12.8	13.7	14.5	13.8
Sept.	12.5	13.4	13.9	13.4
Oct.	12.1	13.0	13.3	13.0
Nov.	11.5	12.4	12.4	12.4
Dec.	10.9	11.8	11.3	11.7
Annual mean yield/bushel	11.65	12.55	12.57	12.55

TABLE 3.—Randomized block analysis of variance of the 1975 observed and predicted mean monthly useable meat weight (pounds) per bushel replicated by months.

Source of variation	Degree freedom	Sum of squares	Mean square	Critical ratio (F)
Months	11	50.96	4.63	
Among models	4	7.97	1.99	
Within models	44	6.84	0.155	12.83*
Total	59	65.77		

*P<0.001

Virginia surf clams is from about May or June through August. Loesch[2] reported a size range of 2 to 18 mm for young-of-the-year surf clams in early October 1974 and estimated their age ranged from 1 to 4.5 mo. Thus, spawning in 1974 occurred from at least June through early September.

The regression of MMUWB on MMST for the 1974 data by the four models resulted in the following equations:

$$\text{Wald's AM regression: } \bar{W} = 10.1 + 0.102\,\bar{C}$$
$$\text{Bartlett's AM regression: } \bar{W} = 11.0 + 0.101\,\bar{C}$$
$$\text{Ricker's GM regression: } \bar{W} = 10.0 + 0.168\,\bar{C}$$
$$\text{Principal axis: } \bar{W} = 10.9 + 0.108\,\bar{C}$$

where $\bar{W}$ = MMUWB; $\bar{C}$ = MMST (degrees Celsius); and the first and second values are the intercept and regression coefficients, respectively.

Predicted MMUWB values in 1975 and their respective AMUWB are presented in Table 2. Analysis of variance (Table 3) indicated a significant difference among the predicted and observed AMUWB values (P<0.001). The Student-Newman-Keuls multiple range test indicated that the only significantly different AMUWB was that associated with the predicted MMUWB estimates derived from Wald's AM regression. Thus, the other three regression models predicted the AMUWB with equally acceptable precision.

The total useable meat yield obtained from the 270,170 bushels of surf clams processed in 1975 was 3,425,654 lb (1,554 metric tons). The sum of the products of MMUWB and monthly landings for all three acceptable models estimated the total useable meat yield with an error ≤0.5%. For all practical purposes the estimate could have been made by using the 1974 AMUWB of 12.5 lb. Total useable meat estimated with this constant was in error by only 1.4%. However, because of seasonal changes in body weight, monthly total useable meat yields should be derived from the MMUWB predicted by one of the acceptable regression equations.

The observed AMUWB for the pooled data of 1974 and 1975 is 12.55 lb and can be used if only annual estimates of useable surf clam meat yields for Virginia stocks are desired. If a substantial change in seasonal harvesting occurred, e.g., a closed season, one of the acceptable regression equations should be used until a new AMUWB constant is estimated.

Barker and Merrill (1967) reported losses of 11 to 20% in body weight with the removal of the viscera from New Jersey surf clams. However, they sampled in May and November when the gonadal portion of the viscera is not near its maximum weight. The present data indicate that the reported DSMN yearly landing weights, based on 17 lb of meats per bushel, must be reduced by 26% to more accurately ascertain the weight of Virginia surf clam meats actually shipped to market.

[2]Loesch, J. G. 1975. Inventory of surf clams in nearshore waters from Cape Henlopen to the False Cape area. Final Rep. 03-4-043-357, U.S. Dept. Commerc., Natl. Mar. Fish. Serv., State–Fed. Fish. Manage. Prog.

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MERCURY IN FISH AND SHELLFISH OF THE NORTHEAST PACIFIC. III. SPINY DOGFISH, *SQUALUS ACANTHIAS*

The spiny dogfish, *Squalus acanthias* Linnaeus, is a small shark that is abundant in the northeast Pacific and has been utilized both as a food fish and as a source of industrial fishery products. This species was heavily harvested in the 1940's for the high vitamin A content in the liver oil until the population was significantly reduced (Alverson and Stansby 1963). The declining resource, along with the availability and low cost of synthetic vitamin A, led to the collapse of the fishery in the early 1950's. Since that time the dogfish population has significantly increased, but the low economic value of the species precluded development of any substantial fishery.

Another limiting factor in commercial handling of dogfish is its rather rapid deterioration. Stansby et al. (1968) found that rancidity, not bacterial spoilage, was the principal factor limiting the ice-storage life of dogfish. If dogfish are properly iced and handled quickly, off flavors due to rancidity and the breakdown products of urea are minimized, and they can be used as food.

Recently there has been a renewed interest in commercial exploitation of this species in Puget Sound, primarily because of the export demand and increased price for frozen dogfish fillets and bellyflaps in Europe. In 1975 only 0.43 million lb of dogfish were landed in the State of Washington for both food and reduction purposes, in contrast to 4.9 million lb landed during 1976 in Puget Sound ports[1] and processed for export to Great Britain and West Germany. As a result of the current interest in the use of Puget Sound dogfish as food and the mercury levels in relation to import regulations of various countries, this investigation was undertaken to determine the mercury levels in dogfish from inland waters of the State of Washington. This report summarizes our findings.

Materials and Methods

The specimens were obtained from commercial gill net and longline catches through the cooperation of the industry and the State of Washington Department of Fisheries. They were collected from the Strait of Georgia near Blaine, Wash. (Figure 1), and from five locations in Puget Sound: Port Townsend, Port Susan, Seabeck (Hood Canal), Seattle (Elliott Bay), and Tacoma (Tacoma Narrows to Carr Inlet). Date and location of capture, round weight, length, and sex were recorded for each fish. Commercial buyers had established a minimum acceptable length of 32 in (81.3 cm) for food processing; therefore, the size distribution of most samples reflected this market practice rather than the normal range of lengths in the dogfish population.

[1]Preliminary landings data, State of Washington Department of Fisheries.