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SEAFOODS: Their Wartime Role in Maintaining Nutritional Standards

By CURTIS L. NEWCOMBE[1] and GRACE J. BLANK[2]

RECENT YEARS have witnessed improved dietary changes, due largely to an increase in knowledge of nutrition and to a wide dissemination of this knowledge.

Since about 1915 there has been a significant upward trend in the consumption of milk, green leafy vegetables, tomatoes, and citrus fruits—the so-called *protective* foods—all of which are extremely rich in those nutrients that are often deficient in low-cost diets. The total weight of food consumed per person per year has remained fairly constant, but there has been a downward trend for meats, grain products, and potatoes, and the use of the protective foods has been increasing. The proportion of calories derived from these latter sources has approximately doubled since the beginning of the century. From a health standpoint this trend is most encouraging, yet the proportion of calories derived from meats, grains, and mature legumes is still over 70 per cent. Probably half the food calories should be derived from milk and milk products, fruits, vegetables, and eggs.

Now, wartime restrictions have changed what were fairly well-balanced family diets into diets deficient not only in certain minerals and vitamins but also in animal proteins essential for the maintenance of normal health. Fresh seafoods, since these are not rationed, should be seriously considered as a source of the indispensable animal proteins.

It is our purpose here to point out the rôle of fishery products as substitutes for those foods generally listed as protective foods but now rationed. As fortifiers of staple foods, fish, oysters, crabs, and other seafoods take very high rank.

Full advantage of these foods has not been taken in the past. The average consumption of seafood per person in the United States during 1938 was only about fifteen pounds. The consumption of oysters was about one-half pound per capita, as compared with more than three pounds in 1880. It is time now that more American people acquire the habit of eating seafoods.

Virginia, a leading maritime state, producing in 1940 around 270,000,000 pounds of fishery products, has a responsibility to perform in safeguarding her fisheries and at the same time assuring their maximum utilization.

LET US CONSIDER THE NUTRITIONAL values of our most important fish, shellfish, and crustacea.

PROTEINS.—Seafoods are rich in digestible proteins of high nutritive value. Of the twenty or more amino acids that constitute body proteins, at least ten must be supplied from different foods and are commonly referred to as "nutritionally essential", since they are not synthesized within the body. Animal proteins are among the best sources of the "nutritionally essential" amino acids and also they are relatively easy to digest. Under our point system of rationing, animal protein intake, other than fowl and seafood, is greatly reduced. Therefore, eating a

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TABLE I

Composition of Seafoods

Proximate Composition of Edible Portions of Fish, Shellfish, and Crustacea in Comparison with Milk, Beef, and Liver, Expressed in Per Cent and in Grams[1] and Calories Per Pound

(Modified after Chatfield and Adams, 1940)

Food	Protein		Fat		Ash		Carbohydrates		Fuel Value in Calories
	Per Cent	*Grams*	*Per Cent*	*Grams*	*Per Cent*	*Grams*	*Per Cent*	*Grams*	
Fish									
Alewife or Branch Herring....	19.4	88.0	4.9	22.2	1.5	6.8		—	550
Bluefish or Taylor	20.5	93.0	4.0	18.1	1.2	5.4		—	535
Butterfish or Dollarfish	18.1	82.1	10.2	46.3	1.4	6.4		—	745
Carp or German Carp	18.2	82.6	2.2	10.0	1.2	5.4		—	420
Croaker or Hardhead	17.8	80.8	2.2	10.0	1.3	5.9		—	415
Drum (Red) or Channel Bass.:	18.0	81.6	0.4	1.8	1.3	5.9		—	345
Eel, American	18.6	84.4	9.1	41.3	1.0	4.5		—	710
Flounder, Summer and Winter.	14.9	67.6	0.5	2.3	1.3	5.9		—	290
Mackerel, Atlantic	18.7	84.8	12.0	54.4	1.2	5.4		—	830
Mackerel, Spanish	19.8	89.8	13.3	60.3	1.3	5.9		—	900
Mullet, Jumping or Fatback...	19.3	87.5	4.4	20.0	1.2	5.4		—	530
Mullet (Sea) or King Whiting.	18.3	83.0	3.0	13.6	1.3	5.9		—	455
Perch, White	19.3	87.5	4.0	18.1	1.2	5.4		—	515
Porgy or Scup	18.6	84.4	4.5	20.4	1.4	6.4		—	520
Rockfish or Striped Bass	18.9	85.7	2.7	12.2	1.2	5.4		—	455
Sea Bass or Black Will	19.2	87.0	1.2	5.4	1.2	5.4		—	395
Shad	18.7	84.8	9.8	44.4	1.4	6.4		—	740
Sturgeon	18.1	82.1	1.9	8.6	1.4	6.4		—	405
Trout (Gray) or Weakfish....	17.8	80.8	1.7	7.7	1.2	5.4		—	390
Average.....	18.5	84.1	4.8	22.0	1.3	5.8		—	534
Shellfish[2]									
Clam or Maninose	13.6	61.6	1.7	7.7	2.0	9.0	2.1	9.5	355
Clam (hard-shelled)	11.1	50.3	0.9	4.1	2.3	10.4	5.9	26.8	345
Mussel (Sea or Edible)	14.4	65.3	2.3	10.4	1.6	7.3	4.5	20.4	435
Oyster	9.8	44.4	2.0	9.0	2.0	9.0	5.9	26.8	365
Average.....	12.2	55.4	1.7	7.8	2.0	8.9	4.6	20.9	375
Crustacea									
Crab (Blue and Pacific)	16.1	73.0	1.6	7.2	1.7	7.7	0.6	2.7	370
Lobster	16.2	73.5	1.9	8.6	2.2	10.0	0.5	2.3	380
Average.....	16.1	73.2	1.7	7.9	1.9	8.8	0.5	2.5	375
Other Foods									
Milk (Cow's) (fresh)	3.5	15.8	3.9	17.7	0.7	3.2	4.9	22.2	310
Beef (Medium) (fresh)	18.2	82.6	19.0	86.2	0.8	3.6	0.	0.	1,110
Liver (Beef) (fresh)	19.7	89.4	3.2	14.6	1.4	6.4	6.0	27.2	600

Source: U. S. Department of Agriculture, *Circular No. 549.*

[1]One pound equals 453.6 grams.

[2]Meat only (not including oyster liquor).

variety of seafood products is highly desirable to assure getting the amino acids which provide the essential building-stones for the body cells. The protein content of most salt-water fishes in Virginia waters ranges from about 17 to 19 per cent, thus comparing favorably with beef and liver and considerably exceeding shellfish (Table I).

FAT.—Flounders and channel bass are low in fat content, whereas butterfish, mackerel, eel, and shad are exceptionally high, ranging from about 10 to 13 per cent. Most other species fall within a range of 1.5 to 5 per cent. The average fat content of local shellfish and crabs is less than half that for most kinds of fish (Table I).

CARBOHYDRATES. — The carbohydrate content of fish is low, usually below 0.5 per cent. This, however, is unimportant from a nutritional standpoint, since the carbohydrate intake of the average American is high and is easily obtained from other unrationed products. Shellfish are relatively high, ranging up to 6 per cent.

MINERALS.—The total mineral or *ash* content (the residue remaining after heating the food to remove all other constituents) varies relatively little in fish, shellfish, and crustacea, ranging from 1 to 2 per cent (Table I). Calcium, phosphorus, magnesium, iron, copper, and iodine are important in appraising the nutrient values of food, since the human body has fairly definite requirements for these elements (Tables II and III). *Calcium* is the mineral that is most likely to be present in insufficient quantity in the diet. Nearly 99 per cent of the calcium and 70 per cent of the *phosphorus* in the body is in the bones and teeth. Milk is con-

TABLE II

Minerals and Seafoods

Mineral Content of the Edible Portion of Fish Fillets, Shellfish, Crustacea, Milk, and Beef

(Modified after Nilson and Coulson, 1939)

Food	In Milligrams per Pound[1]					
	Calcium	*Magnesium*	*Phosphorus*	*Iron*	*Copper*	*Iodine*
Fish						
Cod	49.9	127.1	843.9	2.35	0.19	0.47
Flounder	53.1	138.5	932.1	——	——	0.13
Haddock	74.9	107.1	785.9	2.34	0.19	2.33
Mackerel	21.8	127.6	984.7	5.56	0.52	0.24
Mullet	118.5	144.4	997.9	8.08	0.37	2.20
Shellfish						
Oyster, Eastern	262.9	145.3	508.9	27.69	16.93	0.22
Crustacea						
Blue Crab, white meat.	466.7	152.5	931.6	10.27	7.18	0.19
Blue Crab, claw meat.	320.5	156.6	815.4	3.39	1.67	0.68
Shrimp, raw	246.1	191.1	1,037.4	9.93	1.50	0.10
Other Foods						
Milk	544.8	54.5	422.2	0.91	0.09	0.03
Beef	54.5	109.0	980.6	13.62	0.45	0.004

Source: U. S. Bureau of Fisheries, *Investigational Report, No. 41.*

[1]Conversion note: 1 milligram per pound is equivalent to 2.2 parts per million (p.p.m.). 1 pound equals 453.6 grams. Thus 49.9 milligrams per pound equals 110 p.p.m. (Conversion from p.p.m to milligrams per pound made by the authors.)

sidered as a protective food principally because of its high calcium content. In the event of a milk shortage, seafoods could be utilized as a valuable additional source of this necessary mineral.

Examination of Table II shows that the calcium content of fish compares with that of beef but is much lower than that of shellfish and crustacea. White meat of the blue crab takes highest rank among the seafoods in calcium and is exceeded only a little by milk. Oysters are also high in calcium. They contain nearly four times as much *copper* as beef and thirty or more times as much as cod, haddock, mackerel, and mullet. Oysters greatly exceed beef and milk with respect to *iron* and copper, and contain forty to fifty times as much *iodine* as beef.

Insufficient iodine causes goiter and affords an illustration of the importance of certain elements, although they may be required in only minute quantities. The following values for the iodine content of herring, expressed in parts per billion, are significant: fresh herring, 214; fresh herring roe, salted, 490; fresh smoked herring, 530; dried herring roe, smoked, 800; fresh herring roe, 951; dry herring roe, canned, 3,790. By way of comparison, fresh American lobster equals 138; fresh canned crab meat, 420; fresh Atlantic oysters, 1,160; fresh Atlantic mussels, 1,132; and fresh bluefish, 260.[3] Most fresh agricultural products fall far below these figures. The inland states might profitably increase their consumption of fresh seafoods because of their high iodine content, since these states are the high endemic goiter areas of the nation.

VITAMINS.—Besides minerals there are certain chemical regulators of the body called vitamins that are required for normal nutrition, though these are usually present in foods in very small quantities.

Vitamin A promotes growth and good health, being essential for proper development of the teeth and the visual purple pigment of the retina of the eye. (Night blindness and even total blindness may result from a serious vitamin A deficiency.) Fish oils are especially rich in A. Thus, halibut liver oil contains about 100,000 International Units per 100 grams (272 milligrams per pound); cod liver oil, 85,000 I. U. (230 mgms.); blue fin tuna oil, 78,000 I. U. (212 mgms.); mackerel liver oil as high as 120,000 I. U. (326 mgms. per pound); and shark liver oil, from 5,500 to 120,000 I. U. (15 to 326 mgms. per pound).

Available information indicates that fish muscle, like many meats, does not contain much vitamin A. Salmon, mackerel, and shad are perhaps among the best fish sources, comparing favorably with milk, while fish roe is relatively rich in this vitamin and may be classed as a superior source, along with such stand ard sources as spinach, hens' eggs, and cheese. One pound of shad roe furnishes

TABLE III

Dietary Demands

Approximate Daily Requirements for Average Adult

	RANGE	AVERAGE
Total Calories . .	2,000-4,000	3,000
Protein	60-130 gms.	90.0 gms.
Fat	20-50 gms.	35.0 gms.
Calcium	0.6-1.4 gms.	1.0 gms.
Phosphorus	0.8-1.4 gms.	1.3 gms.
Iron	12-15 mgs.	15.0 mgs.
Copper	2.0-3.5 mgs.	3.0 mgs.
Iodine	0.05-0.5 mg.	0.2 mg.
Vitamins		
A	1.5-3.3 mgs.	3.0 mgs.
B_1–thiamine ...	1.0-2.0 mgs.	1.8 mgs.
B_2–riboflavin ...	2.0-3.0 mgs.	2.5 mgs.
C–ascorbic acid.	70-100 mgs.	80.0 mgs.
D	0.01-0.02 mg.	0.02 mg.

Sources: U. S. Department of Agriculture, *Yearbook*, 1939, and other standard works.

[3]Bridges, *Food and Beverage Analyses*, 1935.

TABLE IV

Dietary Potency of Seafoods

Per Cent of Daily Requirements of Average Adult Provided by 0.5 Pound of Indicated Foods
(Data from Tables I, II, and III)

Food	Calories	Protein	Fat	Calcium	Iron	Copper	Iodine
Mullet	8.8	48.6	28.4	5.9	26.9	6.0	550.0
Flounder	4.8	37.5	3.2	2.6	—	—	30.0
Oyster	6.1	24.6	12.8	13.1	92.3	282.0	55.0
Crab, white meat	6.2	40.5	10.2	23.3	34.2	119.5	50.0
Milk	5.1	8.7	25.2	27.2	3.0	1.5	7.5
Beef	18.5	49.6	123.1	2.7	45.0	7.5	1.0

about 7.0 milligrams of vitamin A, which is more than twice the daily adult requirement. A like amount of hens' eggs furnishes four milligrams or one and one-half times the daily requirement. Pork, the most abundant of the rationed meats, furnishes no vitamin A.

Vitamin B_1, or thiamin, is the vitamin a deficiency of which in the diet leads to such early symptoms as loss of appetite, loss of weight, constipation, slowing of the heart beat, and neuritis. It is also necessary for the proper utilization of carbohydrates by the body. It is therefore particularly important now to have a greater proportion of vitamin B_1 in the diet, since it is inevitable that the carbohydrate intake will be greatly increased due to shortages and high prices with respect to other types of foods. Lobsters, crabs, oysters, and shad roe are relatively high in vitamin B_1 content, one pound of each containing about 1 milligram, or more than half the daily requirement of an average adult. Salmon, sardines, and shrimp are also fairly good sources, comparing favorably with cheese, chicken, potatoes, and orange juice (Tables V and VI).

Many fishes are considered to be good sources of *vitamin* B_2, or riboflavin, a deficiency of which results in loss of hair, weakness, poor growth, skin trouble, and general failure in physical well-being. Broiled mackerel contains almost 3 milligrams of riboflavin per pound. Oysters, herring, shad roe, sardines, and salmon rank among the best sources of supply, comparing favorably with eggs, spinach, and cheese (Table VI).

Studies made so far indicate that most fish contain very little if any *vitamin C* (ascorbic acid). This is the vitamin that affects the production and maintenance of blood and skeletal tissues. A deficiency leads to abnormal growth and development of the teeth and functioning of the blood system. Clams contain 136 milligrams of vitamin C per pound, while shrimp, lobsters, and shad roe are fairly good sources, far exceeding milk (Tables V and VI).

Vitamin D is essential for the absorption of calcium and phosphorus from food. Recent experiments seem to indicate that cereals contain a substance which tends to precipitate calcium of the food in insoluble form in the alimentary tract so that it cannot be absorbed by the body. The effect of the substance may be overcome by taking extra vitamin D. This stresses the dietary need for food high in this vitamin. Most foods contain little or none. Fish liver oils are an excellent source. Other seafoods known to be high in D content include herring, sardines,

and salmon. They far exceed eggs, lean beef, butter, peanuts, and most other common foods. Halibut, clams, oysters, lobsters, scallops, and shrimp also have fair amounts.

The Virginia ribbed mussel, never used commercially until 1940, has since then been used as a principal source of vitamin D in the manufacture of poultry feed. This usage has ". . . made possible perhaps the most significant of recent nutritional contributions to American agriculture."[4]

IN AN ATTEMPT TO EXAMINE THE NUtritive values provided by different sea-

[4]THE COMMONWEALTH, December, 1941, p. 20.

TABLE V

Vitamins in Various Foods

Per Cent of Average Daily Adult Requirements for Vitamins A, B_1, B_2, and C in Half-Pound Portions of Indicated Foods[1]

(Modified after Taylor and others)

FOOD	A	B_1	B_2	C
Fish				
Codfish steak	0.40	9.37	4.33	—
Halibut steak		9.20	16.78	—
Herring, smoked	Fair	Fair	31.75	—
Mackerel, broiled	7.97	11.07	58.23	
Shad roe	113.38	31.50	54.43	14.54
Shad, broiled	6.80	9.54	18.14	
Salmon, canned	14.21	4.53	20.44	
Salmon, fresh	12.28	15.02	21.81	
Sardines, canned	0.63	11.55	31.75	—
Shellfish				
Clams	0.88	2.56	1.31	85.05
Oyster stew	17.65	13.23	0.26	5.51
Oysters, fresh	10.14	31.55	41.67	8.50
Oysters, fried	19.86	20.33	36.60	0.04
Crustacea				
Crab meat	Good	28.95	13.61	35.44
Shrimp	Fair	11.30	14.43	13.09
Lobster, meat		18.99	11.86	14.17
Other Foods				
Milk, whole, fresh	8.74	6.66	19.75	5.81
Beef, round	1.33	18.52	23.11	—
Eggs	69.47	19.30	32.42	
Pork chop, broiled	—	75.60	18.14	
Potatoes, baked	1.70	13.75	5.44	16.54
Oats, rolled, cooked	Trace	12.97	2.53	—
Orange juice, fresh	10.18	13.78	1.37	152.74
Spinach, steamed	907.11	10.17	31.65	47.81
Cheese, American	136.06	6.30	47.63	—
Chicken, lean meat	Fair	14.77	13.66	—

Source: C M Taylor, *Food Values in Shares and Weights*, 1942.

[1]— means absence of; blank space means no satisfactory information. Percentage values have been obtained by calculating the weight in milligrams of each vitamin present in one-half pound of each food. This amount is expressed as a percentage of the estimated average daily adult requirement for each of the four vitamins (Table III).

TABLE VI

Sources of Vitamins

Selected Seafoods Compared with certain Other Foods as Sources of Vitamins, Arranged in Approximate Order of Value (See Table V)

VALUE[1]	A	B_1	B_2	C
Superior	Spinach Cheese, American Shad roe Eggs	Pork chops Oysters, fresh Shad roe Crab meat	Mackerel, broiled Shad roe Cheese, American Oysters, fresh Oysters, fried Eggs Herring, smoked Sardines, canned Spinach, steamed	Orange juice, fresh Clams Spinach, steamed Crab meat
Good	Oysters, fried Oyster stew Crab meat	Oysters, fried Eggs Lobster meat Beef, round	Beef, round Salmon, fresh Salmon, canned Milk, raw, whole Shad, broiled Pork chops, broiled Halibut steak	Potatoes, baked
Fair	Salmon, canned Salmon, fresh Orange juice Oysters, fresh Milk, whole, raw Mackerel, broiled Shad, broiled Herring, smoked Shrimp Chicken meat	Salmon, fresh Chicken, lean meat Orange juice, fresh Potatoes, baked Oyster stew Oats, rolled, cooked Sardines, canned Shrimp Mackerel, broiled Spinach, steamed Shad, broiled Codfish steak Halibut steak Milk, whole, raw Cheese, American Herring, smoked	Shrimp Chicken, lean meat Crab meat Lobster meat	Shad roe Lobster meat Shrimp Oysters, fresh
Poor	Potatoes Beef, round Clams Sardines, canned Codfish steak	Salmon, canned Clams	Potatoes, baked Codfish steak Oats, rolled, cooked Clams Orange juice, fresh Oyster stew	Milk, whole, raw Oyster stew Oysters, fried

[1] "Superior" denotes 26 per cent or more of daily adult requirements; "good," 16 to 26 per cent; "fair," 6 to 16 per cent; "poor," below 6 per cent.

foods, we may consider a half-pound unit (226.8 grams) to represent the quantity consumed daily and evaluate the nutrients contained therein in terms of estimated daily requirements of an average adult as shown in Table III. Comparing the nutrients in typical seafoods with those provided by milk and beef (Table IV) serves to indicate the substitution values of seafoods, and their utility in fortifying the diet. The protein content of many fish compares favorably with that

of beef, and such fish may thus be selected to meet this dietary need. But, as shown in Table IV, a daily portion may provide in addition a high percentage of the calcium and iodine needed daily.

Crabs compare with beef in protein value, while contributing far in excess of calcium, copper, and iodine, half a pound providing about 23, 120, and 50 per cent respectively of the estimated daily requirements of an average adult. Oysters, while only about half as rich in protein as beef, contain far more calcium, iron, copper, and iodine. Clams compare favorably with oysters with respect to essential nutrients. In vitamins, seafoods compare favorably with such common foods as cheese, eggs, beef, milk, and orange juice.

Nutrient assays are subject to variation, depending on the method of analysis used as well as the sources of the foods and the season of collection. Many meat foods undergo losses depending on the methods of cooking and handling. The protein content of seafood, while reduced by cooking, is not subject to as great reduction as other meats, since they require a shorter time for cooking. Certain seafoods, such as shellfish and some crustacea, may be eaten fresh, so that there is no appreciable loss of the main food elements. There is good reason to rank oysters and clams with milk as almost perfectly balanced foods.

This discussion has stressed the double rôle of seafoods: first, as *staple* and *nutritious* articles of diet, varied in their dietary constituents, comparing favorably with meats, poultry, eggs, and milk in essential animal proteins; and second, as concentrated sources of certain of those essential minerals and vitamins that are required as *fortifiers*. The nation's need for foods possessing these properties was never greater.

FROM AN ECONOMIC STANDPOINT, VIRginia possesses several fisheries that are not being utilized for food to the fullest advantage. For example, the annual volume of the herring catch is from 15,000,000 to 18,000,000 pounds and, according to available information, only a small percentage is being processed for food. Herring are relatively cheap, retailing now for about 10 cents a pound, the wholesale price being 2.5 cents a pound. Lean beef costs about 40 cents a pound. Herring equal or far exceed beef in content of protein, vitamins A and D, and iodine, and probably with respect to some other constituents which have not been investigated.

While the menhaden has in the past been used principally as a source of oil and for fertilizer, canners now pack it, with tomato sauce, and ship it abroad for human consumption. This suggests a need for further inquiry into its possible use as food in America. Virginia is a principal producer of menhaden. The volume of catch in 1939 was approximately 128,000,000 pounds, while in 1920 the state produced upward of 400,000,000 pounds.

Increases over current yields through wise policies of fishery management have been demonstrated in the past in Virginia waters. Consequently, in certain at least of our fisheries, greater yields are not simply theoretical possibilities but realities based on experience. On more than one occasion Virginia has taken active steps to restore a declining crab production and the results have been clearly positive. Again, it is well known that Virginia is producing but a fraction of the number of oysters and clams that might be grown were sufficient attention given to these resources. Since 1912, oyster production has dropped about 60 per cent—from approximately 43,000,000 pounds to 17,700,000 pounds in 1940. This downward trend need not necessarily be viewed with alarm, because its principal causes are known. It can

most assuredly be reversed and with consequent benefit to a large percentage of the state's population. Given some of the attention that certain land resources receive, this aquatic resource would yield economic benefits far exceeding the expectations of most people.

The fisheries of Tidewater not only have the advantage of a large and varied catch but are protected from the wartime hazards to which the offshore fisheries are subject. Given an adequate supply of labor and materials, coupled with improved methods of handling and utilization, the production of seafood may be greatly increased, providing relief to current food shortages and an accelerated economy throughout the entire Tidewater area.

Since present methods of recording fishery statistics are inadequate, current catch and employment figures do not exist. It is clear, however, that due to such handicaps as labor and material shortages, the production capacity of certain fishing industries has been sharply curtailed. In some places, the output of crabs for example could be doubled except for lack of help in the crabhouses. The Virginia trawl fishery has been curtailed by a shortage of boats, among other factors. The number of pound nets being operated this year is below normal.

These facts are particularly significant now because of the relatively great amount of food that a fisherman is able to produce as compared with the amount produced by most farmers. It is difficult to arrive at a reliable production figure per individual, but the range per man per year is probably as high as from 20,000 to 100,000 pounds. Pound net fishermen and those working on trawlers frequently exceed these rates. Translating these estimates into terms of agricultural production, and taking 40,000 pounds to represent the average annual production of food fish per fisherman; it is estimated that the cultivation of twenty-three acres of corn, or five acres of potatoes, or three acres of tomatoes or cabbage would be required to produce a similar quantity of food.

Seafood, being a nutritious article of diet and relatively accessible in terms of manpower production effort, may well contribute to a solution of our present national food problem.