A Statistical Analysis of the *OneNumber*™ Food Rating System

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Introduction

A person's "diet" is the food he or she habitually eats. An alternative meaning for the word is a special course of eating that a person may undertake to lose weight. To differentiate the two concepts, we refer to the latter as a "fad diet." Respected health institutions like The American Heart Association take dim views of fad dieting. Instead, they promote eating a wide array of nutritious foods with energy densities aligned to one's weight objective — lose, gain or maintain — and in quantities consistent with the same objective. To quote the AHA:

"*Make smart choices, manage portion sizes*."

Weight management is a separate issue from food quality, though the two are intimately connected. One can still gain weight eating high quality food by eating too much of it. So the American Heart Association adds its second guideline: "manage portion sizes." However, this study focuses only on the first of the AHA's guidelines. It answers whether or not, guided only by *OneNumber*™ (*1#*) ratings, a layperson with no understanding of dietary science will "make smart [food] choices."

The advice is plain enough in principle. The rub lies in how to do it. Our intent in developing *OneNumber* food rating technology was to create a tool to enable its user to "make smart choices" in a technically complex arena: choosing the best foods and avoiding the worst. *OneNumber* grades food on a 0-to-20 scale, taking into account whether the user making the query desires to lose, gain or maintain weight, and whether he/she is under certain doctor-imposed dietary restrictions. To illustrate, let us examine *OneNumber*'s response to an overweight user who needs to know if Alaska king crab is recommended for him. In Figure 1, we see the answer is clearly "Yes." Now see Figure 2 where the same user makes the same query after his doctor tells him to limit his intake of sodium. The energy and nutrient content of the food is unchanged, but the user's needs are different and *OneNumber* revises its advice accordingly.

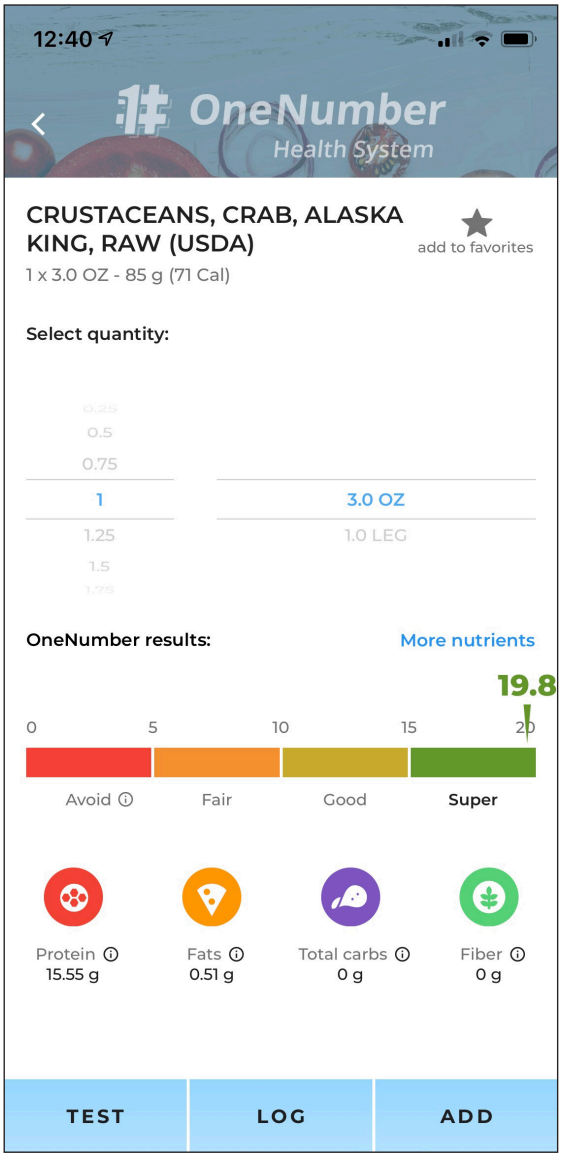

Figure 1) *OneNumber*™advises an overweight male to eat Alaska king crab.

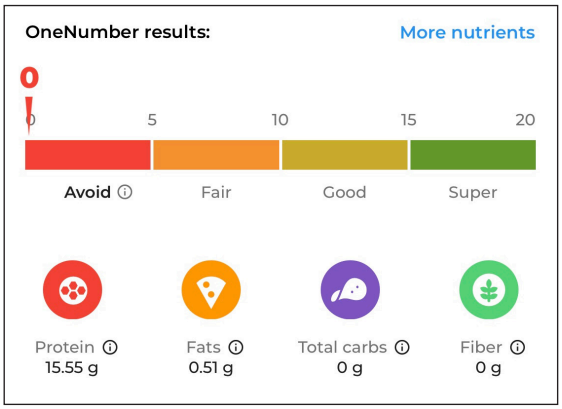

Figure 2) After his doctor places him on a sodium restriction, *OneNumber* advises the same man to avoid Alaska king crab due to its high sodium content. (Sodium content, 835 mg/100 g serving, is shown on a different page.)

Disclosure

The authors of this technical analysis are codevelopers of the *OneNumber* Health System and have financial interests in it.

Abstract

We show how the *OneNumber* food rating system reliably determines relative quality of foods from their energy and nutrient contents, then, based on an individual's weight objective and common doctor-recommended dietary restrictions, rates foods as appropriate or inappropriate for that individual. We also show that the widely used practice of recommending and choosing foods by broad group classifications, eg. "fish" or "fruits," is of little value. This advice is so nonspecific that it cannot reliably direct a layperson away from bad choices and toward better ones.

Summary and conclusions

The purpose of this study, which encompasses 5257 foods in 16 food groups, is to demonstrate that a layperson, relying solely on *OneNumber* ratings to select foods best suited to her specific dietary needs and restrictions, will choose as wisely as a competent nutritionist using FDA food-label data would select foods for herself. We conclude the question in the affirmative for the following reasons:

1. Across a wide variety of foods, there is a strong positive correlation between a food's *OneNumber* rating and the amounts and kinds of food properties that are generally held to be beneficial.

2. Across a wide variety of foods, there is a strong negative correlation between *OneNumber* ratings and the amounts and kinds of food properties that are generally held to be detrimental.

3. *OneNumber* ratings adjust to a person's weight objective and doctor-recommended dietary restrictions, and respond appropriately when a user redefines her needs, such as when she adds a dietary restriction.

4. Dietary advice based on broad food groups, such as an admonition to "eat five servings of fruit every day" without specifying which fruits to eat or avoid, is next to useless, and even arguably deceptive. A layperson, following it to the letter, is more likely to choose incorrectly because people have a general taste preference for sugar. *OneNumber* solves this problem by matching its advice to specific foods rather than groups of foods.

Development objective

The hope that each person will make optimal choices is presumably what drives regulators to require that nutrition data be placed on food labels and restaurant menus. The difficulty is that most laypersons, even with the raw data in hand, do not have the expertise to make highly technical judgments — especially in the short time usually taken for the analysis. *OneNumber* was developed to evaluate a food and, in immediately understandable terms, advise the layperson how well that food meets his or her dietary objectives.

OneNumber™ development

We start with the presumption that every person needs a diet that's rich in fiber and protein and poor in energy density. Energy density has been the subject of much study and has been shown to reduce total energy intake and increase satiety in individuals placed on low energy density diets.[1][2][3] We must make an exception however, for the person who desires to *gain* weight. He needs a diet rich in fiber and protein but with *high* energy density. Except in time of famine, no one derives much dietary benefit from so called "empty Calorie" foods, so in the present climate of widespread obesity, these foods need to be discouraged for all.

We believe, like many others, that increasing the ratio of plant-sourced to animal-sourced food in one's diet is a good thing for two main reasons: 1) we benefit by reducing our intakes of less desirable animal fats,[4] and 2) most of us need more fiber.[5] Nationally, we get only a fraction of the fiber we need and suffer as a result.[6][7] Another important factor is that, unlike protein, finding enough fiber can be difficult.[8] Until he passes age 50, an adult male needs some 65 grams of protein and 38 grams of fiber daily.[9] Let him eat one 10-ounce filet or large chicken breast or fish entrée and he's met his protein goal. But his lettuce side salad would need to be impractically large — six, 6-inch diameter heads or 7 pounds of lettuce — to deliver 38 grams of fiber.[10] Fiber is not present in animal-sourced foods, and most plant-sourced foods have such low fiber densities that getting the fiber we need requires real effort.[8] Therefore we should seek those specific plant-sourced foods that have higher fiber densities. With the above in mind, we developed *OneNumber*.

We first divided people into three groups: those who wish to maintain weight, those who want to lose weight, and those who desire to gain weight. To accommodate certain

doctor-imposed dietary restrictions, we divided each of those three groups into four subgroups: A) no restrictions, B) restricted sodium intake, C) restricted fat and cholesterol intake, and D) restricted sodium, fat and cholesterol.

The resulting 12 groups receive different, group-specific ratings from *OneNumber* that display whether a food is good or bad for them. A user queries by scanning, voicing or keying a food into the app. The app responds by evaluating the match between the food's energy and nutrient contents and the user's weight objective and dietary restrictions. The user is advised to accept or avoid a food based on the degree of match or mismatch that *OneNumber* sees between what's in the food and what the user needs. The value analysis is reported in a single number from 0 (bad) to 20 (good) as we saw in Figures 1 and 2.

12 different *OneNumber* ratings are generated for a single food, but a user sees only the one that applies to him or her. Ratings for a single food can vary widely depending on user differences.

Framework of the *OneNumber* equations

There are 12 different *OneNumber* equations. Equation 1 below forms the framework for all 12.

$$OneNumber = \frac{a(Nutrient\ \ Density)}{b(Energy\ \ Density)} \pm cC_1 \pm dC_2 \pm eC_3 \pm fC_4 \pm gC_5$$

(eq 1)

Where:
Nutrient Density (g/100 g food) and Energy Density (Kcal/100 g food) apply to the food being evaluated, C1 – C5 are dimensionless factors and a-g are empirically derived coefficients that along with their signs, are varied to fit *OneNumber* ratings to each of the 12 user profiles.

Some important points and assumptions concerning *OneNumber* are:

1. Except to decrease food ratings for high sodium and high cholesterol, the 12 equations do not consider micronutrients when grading foods for a specific user. However, the *OneNumber* Pro app will track and report micronutrients to enable a user to monitor and adjust micronutrient consumption.

2. FDA-sanctioned additives, whether approved by testing or by GRAS, are assumed to be safe in *OneNumber*.

3. Equation 1 ignores the effects of diet-induced thermogenesis (DIT).

4. Errors in database entries will cause errors in *OneNumber* ratings. For instance, a popular restaurant chain's side dish called "brown butter topping" earns a surprise rating of 20 because one 4-ounce serving contains — we are told — 300 grams (2/3 pound) of protein. With hundreds of thousands of rows in the databases in use, other entry errors are inevitable.

5. Some values calculated by the 12 equations fall below 0 or above 20. We truncate the calculated values at 0 and 20 to simplify the ratings for users. Plus, we see little value in telling them that raw spinach is better for them than raw broccoli when both are excellent, or that one sugared cola is worse than another when both are poorly rated.

6. The *OneNumber* rating does not take food allergies into account.

7. Due to the importance of fiber content and fiber density, plant vs. animal source is a factor in all 12 *OneNumber* equations. Other things equal, all of them will favor plant over animal sources. There are many other factors in the equations however, so it will be common for animal-sourced foods to be highly rated when the ratio of protein content to energy density is high, as with lean fish.

8. We are working on extending the application of *OneNumber* dietary principles to other medical conditions like diabetes and kidney dysfunction, but this technology is not fully developed.

9. *OneNumber* dietary advice is given with only one objective in mind: to improve the health and nutrition of *OneNumber* users. We take no position, as some food rating systems do, on any other issue, whether it be climate change, environmental sustainability, vegetarianism, animal rights, poverty or any social cause or agenda.

The challenge in developing *OneNumber* was not in writing equation 1, but in deriving the empirical coefficients so the 12 equations would give appropriate answers and respond appropriately to changes in a user's profile. For one example of many, there is a considerable amount of sodium in our food supply.[11] It was difficult to strike a balance between being restrictive enough to discourage a hypertensive user from consuming high-sodium foods but

not so restrictive as to prevent him finding something to eat. Most challenging was applying personalized *OneNumber* ratings to restaurant menu items that contain many ingredients under a single name, such as Red Lobster's Tuna Lunch (which earns an aggregate rating of 18.8 for someone who is trying to lose weight and has no dietary restrictions).

Study results

The study answers the following question: *Would an inexpert user, guided solely by OneNumber, make substantially the same food choices she would make if she herself were a competent nutritionist with ample time to choose?* We answer the primary question by answering four subquestions. First, assume a user with a specific weight objective and dietary needs evaluates thousands of different foods with *OneNumber*. Questions 1 and 2 below, if answered affirmatively, will establish that *OneNumber* food ratings indeed direct a user to the right foods, and away from the wrong ones, without that person knowing dietary science.

1. Is there a positive correlation between *OneNumber* ratings and the energy density and macronutrient needs of that user?

2. Is there a negative correlation between *OneNumber* ratings and the energy densities and specific macronutrients and micronutrients that user should avoid?

3. Does a food's *OneNumber* rating adjust itself appropriately when the user redefines her needs, for example, when she changes her weight objective?

4. Does *OneNumber* solve the problems a layperson can encounter when he follows oversimplified advice like: "eat five helpings of fruit every day" or "avoid processed foods?"

Is the *OneNumber* rating a valid measure of food quality?

Let us examine 264 fish and shellfish choices for an overweight user who has no dietary restrictions (Figure 3). This chart shows protein content (green dots) and energy density (red dots) for each of the 264 foods. Each pair of vertically aligned dots, one red and one green, represents one food. The first thing we notice is what our nutritionists have been saying all along: most fish are good for us. Many fish and shellfish couple low energy density — around 100 Calories for a 3-1/2 ounce serving — with rich protein content. This makes them some of nature's best foods.

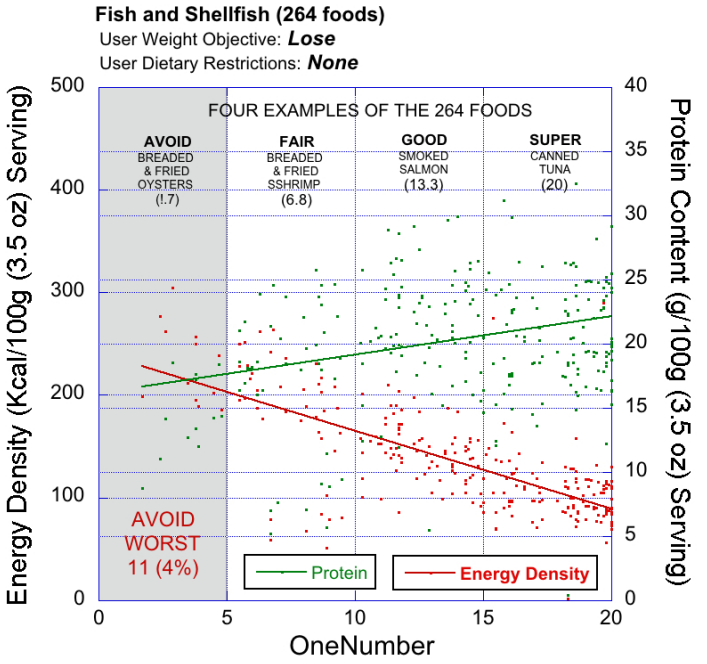

Figure 3) The relationships between *OneNumber* and energy density ($r = -0.70$, $p < 0.0001$, $N = 264$, $-.757 < \rho < -.633$), and *OneNumber* and protein content ($r = 0.26$, $p < 0.001$, $N = 264$, $.144 < \rho < .369$) for fish and shellfish. The *OneNumber* ratings are for losing weight with no dietary restrictions.

We see that on the left side of the chart the ratio of nutrient content to energy density is smaller and improves as we move toward higher *OneNumber* ratings on the right. We list four example foods to highlight the four *OneNumber* zones: Avoid (0-5), Fair (5-10), Good (10-15) and Super (>15). Ratings will change as user's needs vary. For example, a user who is under a cholesterol restriction would be told to avoid shrimp, however it was cooked.

Our standing recommendation is that users avoid foods rated 5 or lower because they have the least desirable nutrient content/energy density. Only 11 of the 264 fish and shellfish data pairs (4%) fall into the zone to be avoided. So a random selection of fish has a 96% chance of being at least fair and an 80% chance of being good to super for an overweight person with no dietary restriction. The figure also shows that choosing a fish rated 15 to 20 is likely to be better than choosing one rated 10 to 15, other things equal.

While Figure 3 pictures why our nutritionist recommends fish, it also illustrates her quandary. How should she handle those 11 foods low in nutrient/energy density that she'd advise her overweight clients to avoid? Let's examine them, along with their USDA National Database numbers[10], on the following page.

15168 Mollusks, oyster, eastern, cooked, breaded and fried
15027 Fish, fish sticks, frozen, prepared
15041 Fish, herring, Atlantic, pickled
83110 Fish, mackerel, salted
15251 Salmon nuggets, breaded, frozen, heated
15075 Fish, sablefish, smoked
15208 Fish, sablefish, cooked, dry heat
15074 Fish, sablefish, raw
15252 Salmon nuggets, cooked as purchased, unheated
15158 Mollusks, clam, mixed species, cooked, breaded and fried
15196 Fish, halibut, Greenland, cooked, dry heat
15038 Fish, halibut, Greenland, raw

So, to communicate precisely what she wants her overweight clients to do, should our nutritionist advise:

"*Eat fish except mollusks, oyster, eastern, cooked, breaded and fried, and fish, fish sticks frozen . . .*" and so on?

We think not.

Wait a minute! (We said to ourselves.) Halibut is a *good* fish. Why is it on the wrong end of the energy density line? It seems that Greenland halibut (*Reinhardtius hippoglossoides*, *OneNumber* rated at 4.8) is not the same fish as Atlantic halibut (*Hippoglossus hippoglossus*, *OneNumber* rated at 18.8). The former contains ten times more fat and 20% less protein than the latter[10] though both are found near Greenland.[12] Bottom line? Before you order halibut, ask the waiter for its Latin name.

Now let us complicate our nutritionist's life even more. Suppose we have three obese *OneNumber* users we'll call A, B, and C. All were told by their doctors to lose weight. User A is otherwise unrestricted. User B is hypertensive and on a low sodium regimen. C suffers from hypertension and hyperlipidemia, and is restricted in sodium, fat and cholesterol. They told their restrictions to *OneNumber* when they entered their profiles, so the app assigned different formulas to each. User A gets equation 5, user B is assigned equation 6 and user C gets equation 8. (These are our internal numbers; they don't refer to equations in this paper.) All three go to a seafood restaurant that serves the 264 items in the USDA fish and shellfish database.

Using the assigned equations, *OneNumber* performs a value analysis, then reports to each user, on a scale of 0 to 20, the degree of match or mismatch between each food and that user's needs. The results are summarized for users A and B in Figure 4. (These are the same points in Figure 3, but replotted with sodium content as the independent variable and the *OneNumber* ratings — green for A and red for B — as the dependent variables.) For fish on the left side that contain little native sodium there is little difference in the two users' ratings, but as sodium content increases to the right, B's ratings fall lower and he is guided away from the high-sodium fish. A's ratings are unaffected by sodium content. Alaska king crab is highlighted.

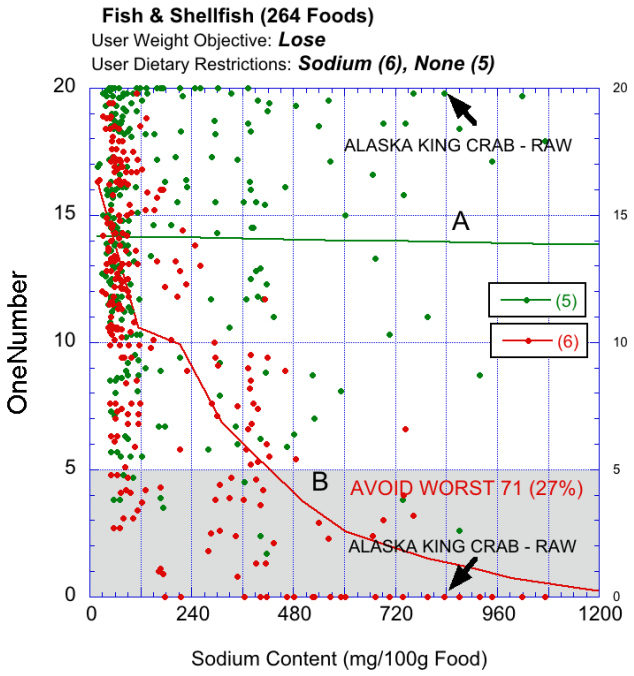

Figure 4) Fish and shellfish rating from equation 5 (no restrictions) is not affected by sodium concentration (r = -0.049, p > .05, N = 264, -.169 < ρ < .072). User B's rating is calculated by eq. 6 and correlates negatively with sodium content. (r = -0.377, p < .0001, N = 264, -0.476 < ρ < -0.268). Both users are trying to lose weight.

The same pattern is seen in A's and C's ratings shown on Figure 5 on the following page. However, because C is restricted for fat and cholesterol in addition to sodium, C's options are even more limited.

To summarize, user A, overweight but with no restrictions, was directed away from only 11 fish — those with the lowest nutrient/energy density ratios. High sodium took away an additional 60 from user B, and for C another 62 foods dropped out owing to high fat and cholesterol. So *OneNumber* denies 4% of fish to A, places 27% of them off-limits for B and denies C 50% of them. The most restricted *OneNumber* user, C, still has 131 better (for him) fish from which to choose.

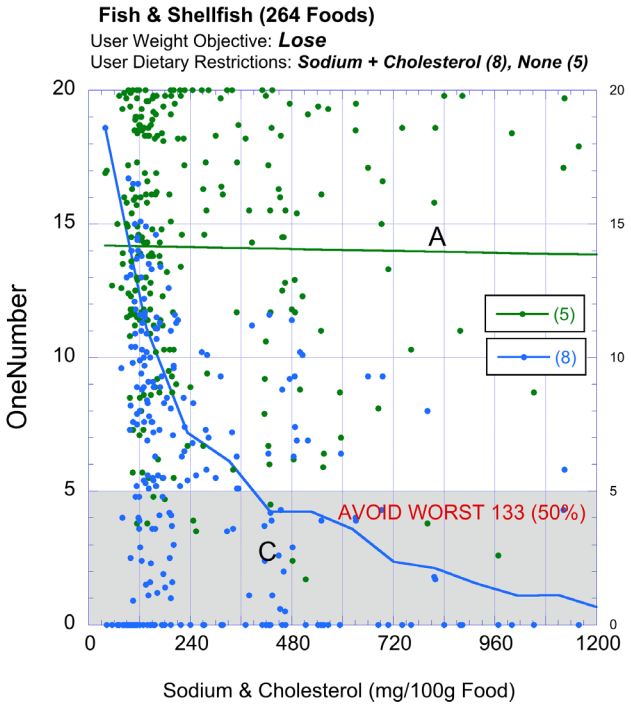

Figure 5) The *OneNumber* ratings for user A from equation 5 (no restrictions) is not affected by sodium and cholesterol content (r = -0.050, p > .05, N = 264, -0.170 < ρ < 0.071). User C is sodium and fat/cholesterol restricted. His *OneNumber* rating is calculated by equation 8 and correlates negatively with concentration of those attributes (r = -0.291, p < .0001, N = 264, -0.398 < ρ < -0.176). Both users are trying to lose weight.

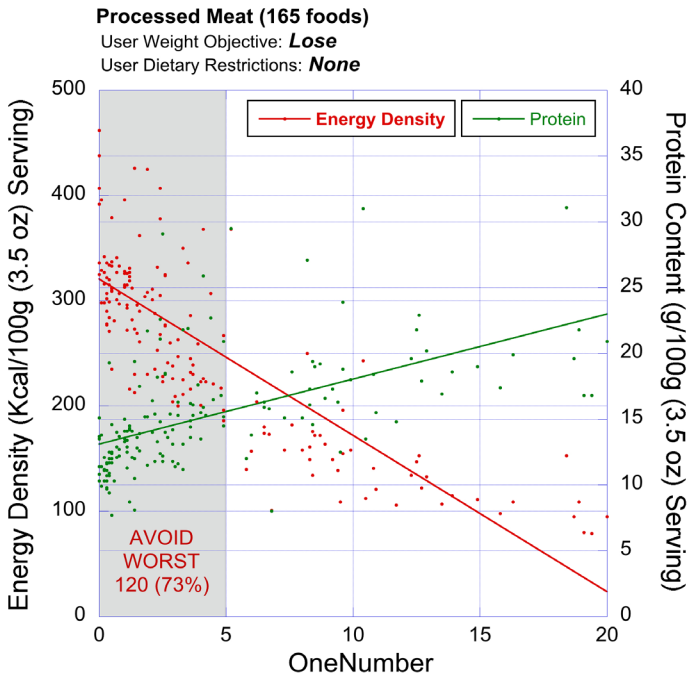

Figure 6) The relationships between *OneNumber* and protein content (r = 0.57, p < .0001, N = 165, .457 < ρ < .665) and *OneNumber* and energy density (r = -0.79, p < .001, N = 165, -.841< ρ < -.725) for processed meats for a user who wants to lose weight.

Processed meats

Let's next examine one of our nutritionist's least favorite food groups: processed meats. One glance at Figure 6 tells us why she holds a poor opinion of processed meats. To get the same amount of protein from most sausage compared to fish, one must consume some three times more energy. Small wonder that dietary experts advise us to "avoid processed meats."

But even in this much-maligned food group one can find wholesome, nutritious things to eat. Dozens are rated 10 or better (good to super) containing more protein and less fat than others. So a shopper guided by higher ratings might be able to find a few she likes and gain the convenience of processed meats without sacrificing quality.

Nuts and seeds

Growers' associations and even some dietary experts advise that nuts and seeds are "good for us" with no qualification. However, this statement is true only for underweight and normal weight people.

The reason nuts are not good for overweight people is that they have the highest average energy density of all food groups. Figure 8 shows why: They are loaded with fat. Nuts and seeds shown in the large cluster in the upper left run 50% to 60% fat by weight. Fifty times more fat than most fruits and vegetables, even approaching the fat content of dairy butter. True, it's mostly unsaturated plant fat and has no cholesterol, but that's only minor consolation for those struggling with weight. At 9 Calories per gram, plant fat will cause obesity, and all its attendant problems, if overindulged in. Few foods are easier to overindulge in than nuts. They combine fat and often salt — tastes many of us love together — with very high energy density. Energy dense foods, per Calorie consumed, are slower to register feelings of fullness than energy lean foods[3] and we often eat nuts at times when we are minimally aware of how much we're eating. To make matters worse, growers' associations aggressively publicize product benefits

but omit accompanying qualifying statements. They are more likely to tell us the first two sentences of the Mayo Clinic newsletter[13] quoted below than they are to tell us the third (emphasis is ours).

"*Almonds and other tree nuts can improve blood cholesterol. A recent study concluded that a diet supplemented with walnuts can lower the risk of heart complications in people with history of a heart attack. All nuts are high in calories, so a handful added to a salad or eaten as a snack will do.*"

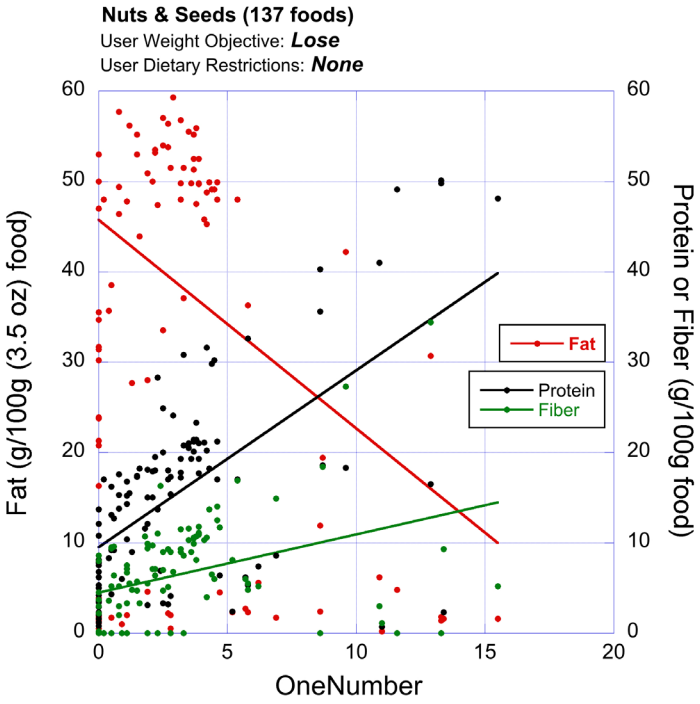

Figure 7) The relationships between *OneNumber* and protein content (r = 0.620, p < .0001, N = 137, .505 < ρ < .714), *OneNumber* and fiber content (r = 0.374, p < .0001, N = 137, 0.220 < ρ < 0.510) and *OneNumber* and fat content (r = -0.317, p < .0001, N = 137, -0.460 < ρ < -0.158) for nuts and seeds for a user who wants to lose weight.

A corollary to the "nuts are good for you" advice is the popular "good fat/bad fat" mantra. It can lead people astray with the notion that if plant fats are "good," more of them must be even better. Our advisors want us to eat plant fats *in place of* animal fats, but the uninitiated can take the phrase to mean eat plant fats *in addition to* animal fats. What advisors should be saying to us, if we're overweight, is that there are no "good fats," only "bad fats" and "worse fats." Everyone needs fats in their diets, and plant fats are preferable. But fats are found everywhere in our food. Even a cracked-wheat hamburger bun (USDA 28312, *OneNumber*: 6.8) contains 3.6 grams of fat.[10]

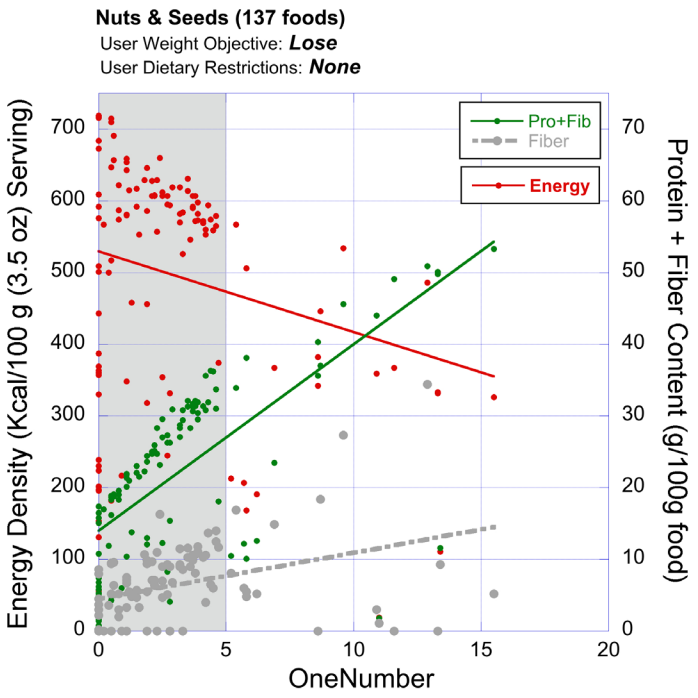

Figure 8) The relationships between *OneNumber* and energy density (r = -0.216, p < .01, N = 137, -0.370 < ρ < -0.050), *OneNumber* and fiber content (r = 0.374, p < .0001, N = 137, 0.220 < ρ < 0.510) and *OneNumber* and protein plus fiber content (r = 0.690, p < .0001, N = 137, 0.591 < ρ < 0.768) for nuts and seeds for a user who wants to lose weight.

A handful of nuts will give us some protein and fiber, but other sources of both nutrients are far better for an overweight person. For protein, compare Figure 8 for nuts to Figure 3 for fish. To get 20 grams of protein from nuts requires consuming some six times more energy than with fish. Even the average sausage in Figure 6 has a better protein/energy relationship. To get the same amount of fiber from nuts as from blackberries requires consuming around ten times more energy. It's true that with nuts the protein and fiber come in a single package, but getting that nutrition still requires consuming 3-to-5 times more energy than getting it from better sources does. Nuts and seeds are not for overweight people.

On the other hand, few food groups better illustrate *OneNumber*'s ability to tailor its advice to the user than this one. Going by the standard recommendation to avoid any food rated 5 or less, Figure 8 shows that a dieter has no business parking beside the nut bowl. But look at the *OneNumber* ratings for an underweight user (Figure 9): if one needs to gain weight nutritiously there is hardly a better choice — protein, fiber and concentrated energy from plant fats — all wrapped in a small and tasty package.

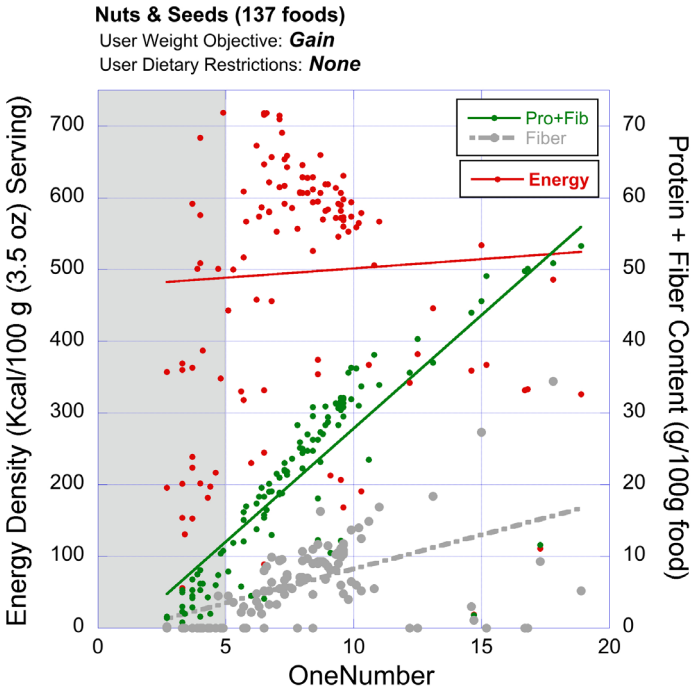

Figure 9) Nuts and seeds are better choices for one who wants to gain weight. *OneNumber* and energy density (r = 0.049, p > .05, N = 137, -0.120 < ρ < 0.215), *OneNumber* and fiber content (r = 0.541, p < .0001, N = 137, 0.411 < ρ < 0.650) and *OneNumber* and fiber plus protein content (r = 0.821, p < .0001, N = 137, 0.757 < ρ < 0.869) for nuts and seeds for a user who wants to gain weight.

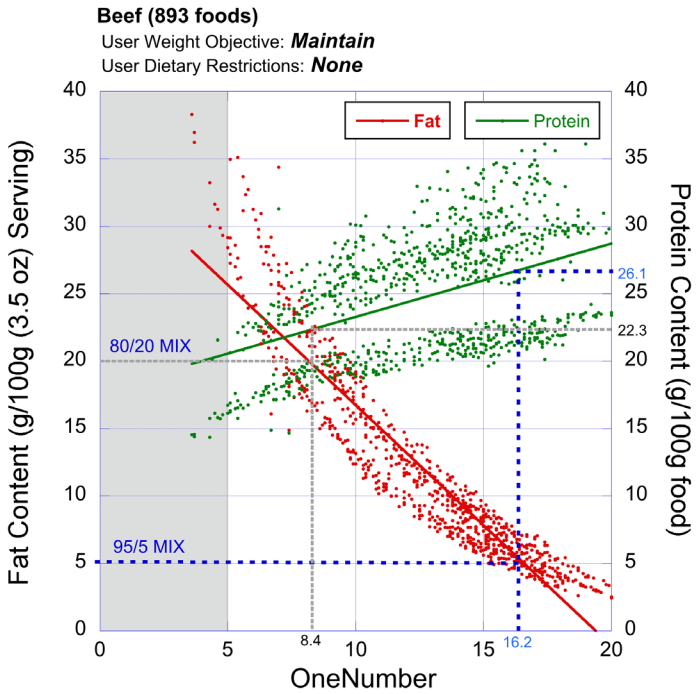

Figure 10) Dotted lines show how a shopper improves protein intake by changing his preferred ground beef mix from a lower to higher *OneNumber* rating. The relationships between *OneNumber* and fat content (r = -0.94, p < 0.001, N = 893, -0.947 < ρ < -0.932) and *OneNumber* and protein content (r = 0.46, p < .0001, N = 893, 0.407 < ρ < 0.510) for 893 beef products for a user who wants to maintain weight. See Figure 11 for the effect this decision has on the shopper's energy intake.

Higher *OneNumber* ratings are better

We have discussed one of our two standing recommendations: Avoid foods with *OneNumber* ratings less than 5. The second is equally important:

Whatever you habitually eat, seek foods you like that have higher OneNumber *ratings.*

This is illustrated in Figures 10 and 11. Figure 10 shows protein content (green) and fat content (red) for 893 beef products as a function of each product's *OneNumber*.

Consider a shopper who has no knowledge of dietary science, but wishes to eat better. He typically buys the less-expensive 80/20 ground beef mix, but queries the 95/05 grind and, because it has a higher *OneNumber* rating, purchases it instead. By this simple expedient, our shopper increases the protein content of his ground beef by 15% to 20%. And as a bonus, he also reduces the energy content of his ground beef recipes by some 40% (Figure 11).

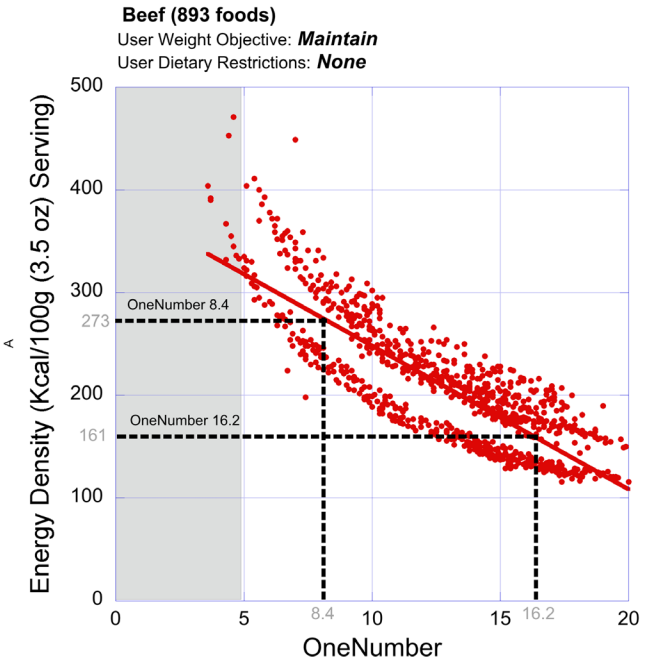

Figure 11) By raising *OneNumber* from 8.4 to 16.2 in Figure 9, a shopper cuts the energy content of his ground beef recipes by about 40%. The *OneNumber* relationship with energy density for beef products (r = -0.84, p < 0.0001, N = 893, -0.858 < ρ < -0.820).

This same principle works across all food groups because *OneNumber* correlates positively with positive food attributes, and negatively with negative food attributes.

Looking further at the properties of beef and beef products, one sees another example of how *OneNumber* adjusts to individual needs. Note that ratings in Figure 10 are calculated for a user who wishes to maintain weight while Figure 12 shows the same food properties but with ratings calculated for a person who wants to lose. The food is the same but the user is different. Comparing Figures 10 and 12, the effect of changing our user's weight objective from maintain to lose is to shift the *OneNumber* ratings to the left, lowering them across the board. If our user follows our advice and avoids ratings below 5, he automatically lowers his maximum allowable energy intake on beef products from about 350 Kcal/serving to about 275 Kcal/serving.

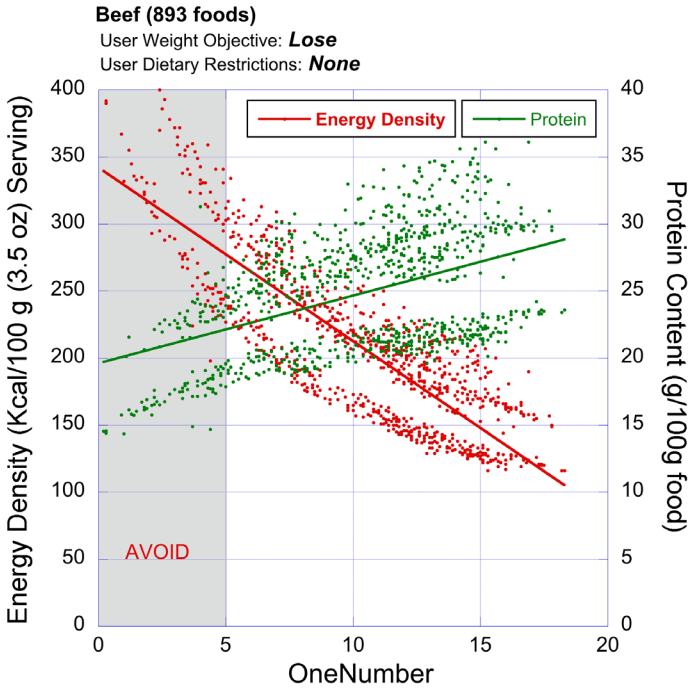

Figure 12) Compare *OneNumber* beef-product values for a user who wants to lose weight, to the user in Figure 10 who desires to maintain weight. Approximately 1.4% of the worst beef products are off-limits to the maintainer (Figure 10) but when the weight objective is changed to lose, the *OneNumber* ratings shift to the left and the bottom 29% of all beef products are placed off-limits. For protein ($r = 0.46$, $p < .0001$, $N = 893$, $0.407 < \rho < 0.510$) for energy density ($r = -0.84$, $p < 0.0001$, $N = 893$, $-0.858 < \rho < -0.820$).

Vegetables

Figure 13 shows the relationship of *OneNumber* to three attributes of vegetables: energy density, fiber and protein. It is immediately apparent why our nutritionist favors vegetables. Even setting aside the plentiful array of micronutrients often found in them, we see that vegetables are blessed with the lowest energy density of all — exactly opposite nuts and seeds. Indeed, many of the veggies on the right side of the chart are so low in energy that eating enough of them to get fat would be nearly impossible.

Almost 90% of raw vegetables are recommended by *OneNumber* for the person who is trying to lose weight. Adding restrictions for sodium, fat and cholesterol hardly affects the ratings because vegetables in general carry very little of these elements. An astonishing 49 different green, leafy vegetables carry the maximum possible *OneNumber* rating of 20. Except for more starchy vegetables on the left side of the chart, notably potatoes, an overweight person is hardly restricted as long as he is thrifty with any sauces or dressings.

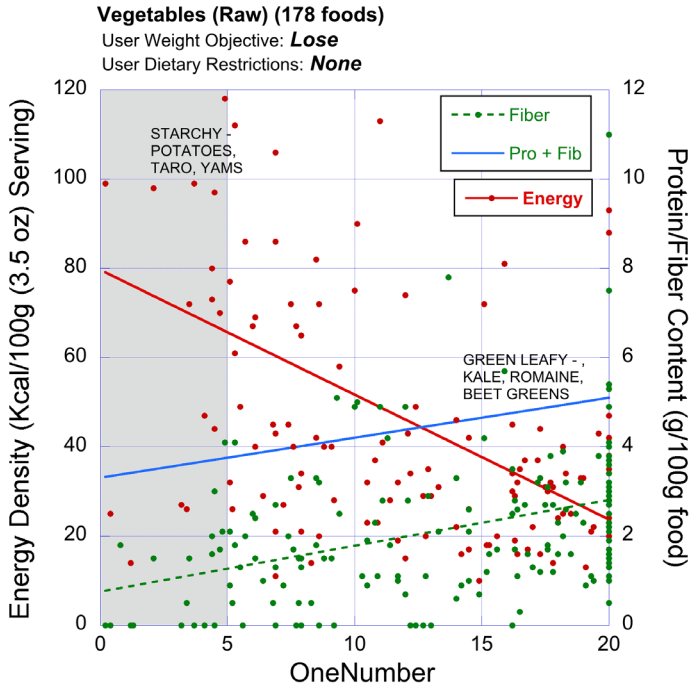

Figure 13) The relationships between *OneNumber* and energy density ($r = -0.53$, $p < 0.0001$, $N = 178$, $-0.628 < \rho < -0.415$), fiber content ($r = 0.04$, $p > .05$, $N = 178$, $-0.11 < \rho < 0.19$) and *OneNumber* and protein + fiber content ($r = 0.20$, $p < 0.01$, $N = 178$, $0.055 < \rho < 0.337$) for 178 raw vegetables for a user who wants to lose weight.

Fruit (and the dangers of "groupthink")

By that term, we mean lumping large numbers of foods under a single group heading, like "vegetables" or "fruits." How many times do we hear dietary advice expressed in group terms: "avoid processed," "eat whole foods" and the like? In defense of our dietary gurus, before *OneNumber* it was necessary to speak in general terms so laypersons

could grasp the message. But it's time to stop. The message to the layperson can be misleading and counterproductive. Let's compare two highly recommended food groups to see how group-centered advice (like the venerable food pyramid) can be right in one instance and wrong in another. We will compare vegetables (Figure 13) with fruits (Figure 14).

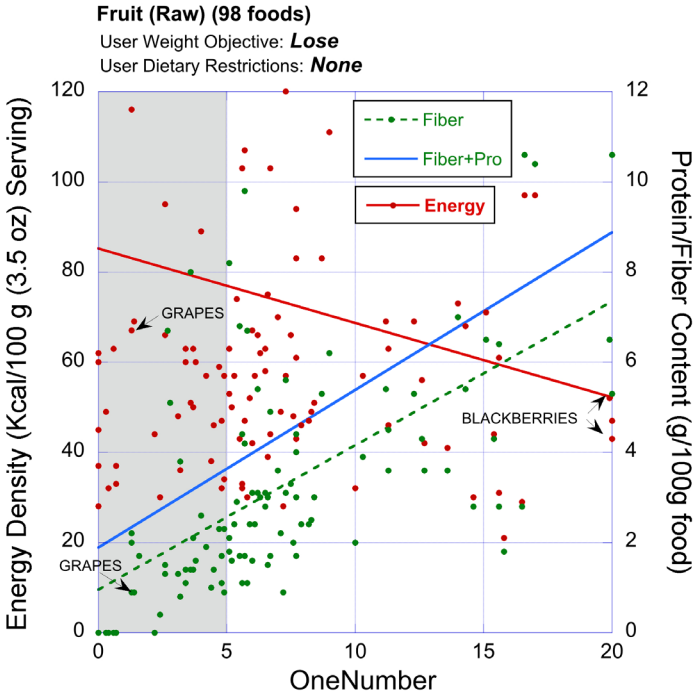

Figure 14) Compared to vegetables in Figure 13, raw fruits have less desirable nutrient/energy properties. *OneNumber* and energy density (r = -0.124, p > .05, N = 98, -0.3154 < ρ < 0.076), *OneNumber* and fiber content (r = 0.743, p < 0.001, N = 98, 0.64 < ρ < 0.82) and *OneNumber* and protein + fiber content (r = 0.705, p < 0.001, N = 98, 0.59 < ρ < 0.79).

We do hear we should choose green, leafy vegetables over starchy vegetables, a preference clearly validated in Figure 13 where literally dozens of green leafy vegetables earn the maximum *OneNumber* rating of 20, while starchy vegetables languish at 3 to 5. But the most striking thing about the highly rated vegetables is that they contain so little energy. Sans heavy dressings and sauces, we can consume them by the tubful, loading up on micronutrients with little danger of gaining weight. Many studies show that a low energy density diet is associated with lower total energy consumption and earlier feelings of satiety.[1][2][3] Give our experts an A+ for their incessant promotion of green vegetables as healthy choices.

Now let us compare fruits, where we hear similar guidance. "Eat five helpings of fruit every day" says the USDA in its Healthy Eating Index (HEI).[14] There are occasional qualifiers like "berries are good for you," but the overriding impression left to the layman is that all fruits are equal so he's free to follow his taste buds while still thinking he's eating well. Figure 14 paints a different picture. Compared to vegetables, far more fruits are bunched on the left in the undesirable zone of low nutrient content and high energy density.

It's sugar that gives fruit higher energy density. Much ado has been made lately about sugar and we seem to view it with ambivalence. Natural sugar is good. It must be, since it's "all natural" (like scorpions and poison ivy) and we are adjured to eat raw fruit till we swim in it. But sugar added by man is bad. It must be because it was added in pursuit of profit so we label it on the food package and discourage its consumption. What difference does it make? Any sugar helps make us fat, so why quibble about who added it? Compare 100 g of raw blackberries (4.88 g sugar, *OneNumber*: 20) to the same weight of frozen unsweetened (no sugar added) blackberries (10.66 g sugar, *OneNumber*: 12.2).[10] Where does that extra 6 g of sugar that costs us 24 Calories and costs the frozen fruit eight *OneNumber* points come from? It comes from nature. A grower will often send his late-harvest fruit to the frozen market and the earlier harvested fruit to the fresh market. Bottom line, it doesn't matter who put the sugar in the food. What matters is whether or not it's there when we eat it.

To illustrate the folly of expressing nutritional advice by food group, lets compare grapes with blackberries in Figure 14. One cup (about 150 g) of raw grapes (OneNumber: 1.4) has 104 Calories and delivers 1.09 g protein, 1.34 g fiber and 23.37 g sugar.[10] By comparison, one cup of raw blackberries (*OneNumber*: 20) carries 62 Calories (40% fewer), 2 g protein (83% more), 7.63 g fiber (569% more) and 7.03 g sugar (70% less) than the cup of grapes.[10] Yet when the USDA tells us to "eat five helpings of fruit every day," we can comply by eating either grapes or blackberries. Which will we choose?

Perhaps a clue can be found at the supermarket where the smallest container of grapes we can buy weighs 3 pounds, and the largest container of blackberries weighs 12 ounces. We see a better clue on the Agricultural Marketing Resource Center web page[15] where the unit of blackberry production is a million pounds while the unit of grape production is a million *tons*. When we work out the conversion and subtract the grape production used for canned grapes (miniscule), grape juice (significant), raisins

(very significant) and wine (whopping!), we are left with about 1500 million pounds of grapes we presumably eat each year. Total national blackberry consumption, including imports, is an estimated 263 million pounds.[16] Even assuming no blackberries were canned or made into juice or wine, that's still more than five times more raw grapes eaten than raw blackberries. Gosh, that would explain the 3 pounds vs. 12 ounces conundrum at the supermarket, where the ratio is 4:1 in favor of grapes. Conclusion? We love the taste of sugar.

Our gurus are often right too

A common admonition making the rounds is to avoid processed foods in favor of whole foods that are "close to nature." Consider Figures 15 and 16. Figure 15 shows 2386 plant-sourced foods as a function of their *OneNumber*. Of the 2386 foods, 2107 had been processed. The 279 raw unprocessed plant-sourced foods are also pictured separately in Figure 16. The first thing that jumps out of the processed-foods data set (Figure 15) is how the data crowds the left side, just as our experts have told us. Food processors add sugar and fat for marketing advantage.

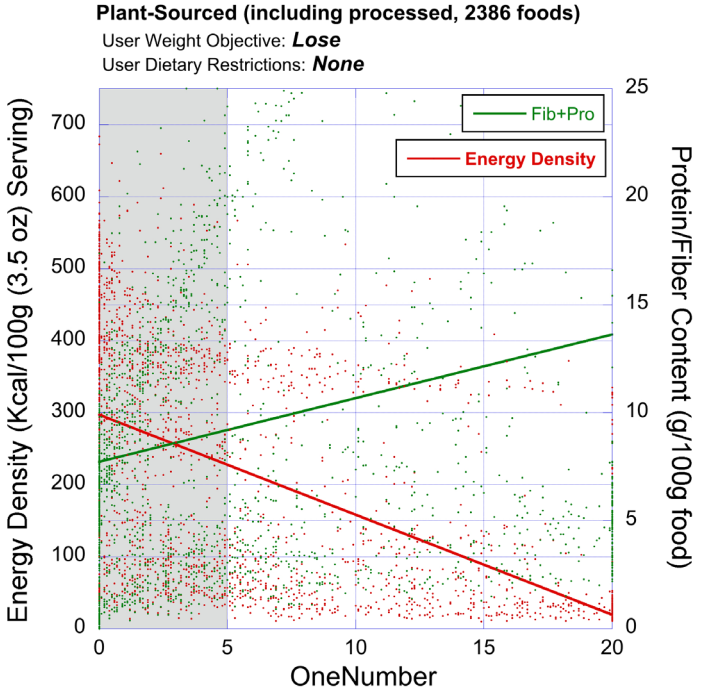

Figure 15) The relationships between *OneNumber* and energy density (r = -0.53, p < 0.001, N = 2386, -0.559 < ρ < -0.501), and *OneNumber* and fiber + protein content (r = 0.18, p < 0.0001, N = 2386, 0.147 < ρ < 0.225) for 2386 plant-sourced foods. 2107 (88%) have been processed.

Now compare the data set for unprocessed foods in Figure 16. If we remove processed foods, the unprocessed foods that remain are far healthier. Only 33 (12%) rate 5 or lower, and 177 (63%) have ratings of 10 and above. So a person who forgoes processed foods entirely and makes random plant-based, whole-food choices has about a 90% chance of eating acceptable foods and an almost two-in-three chance of consuming foods that are good to great. That's exactly what our gurus mean when they say we need to get "closer to nature" with our food.

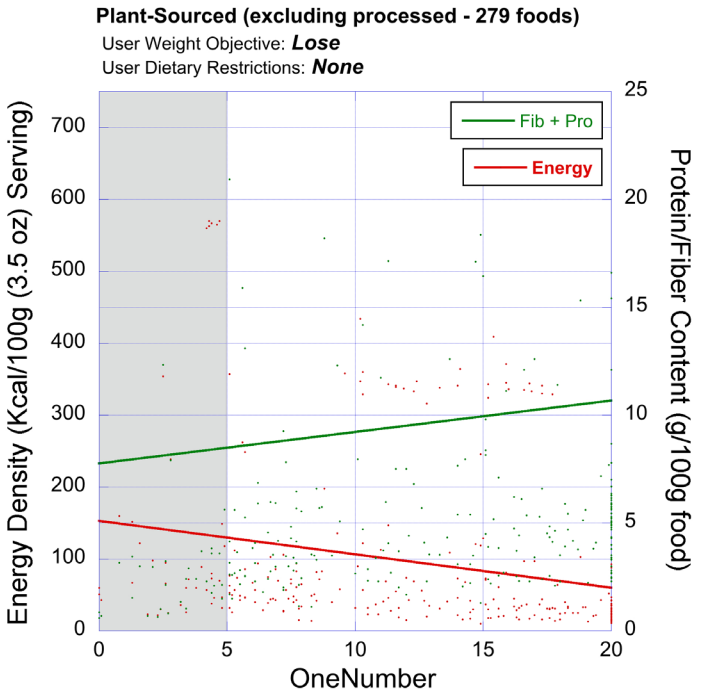

Figure 16) The relationships between *OneNumber* and energy density (r = -0.257, p < 0.001, N = 279, -0.365 < ρ < -0.142), and *OneNumber* and protein plus fiber (r = 0.041, p > 0.05, N = 279, -0.079 < ρ < 0.160) for unprocessed plant-sourced foods for a user with no dietary restrictions but who needs to lose weight.

Contrast this with the data set in Figure 15 that includes both processed and unprocessed foods. If the aforementioned person chose randomly from all these foods the odds he'd get an acceptable food (*OneNumber* > 5) would diminish to only 43%, and the odds that he'd hit on one that was good to super (*OneNumber* > 10) would drop to only 27%. So the recommendation to avoid processed foods and eat "closer to nature" is sound nutritional advice.

But let us reflect on food processing for a moment. It has been evolving for several millennia and arguably comprises some of the most useful technology mankind has contrived. It has prevented starvation, and even extended man's exploration to outer space. From drying, smoking, salting and other ancient forms to today's refrigeration, canning, packaging and freezing, man's ability to extend food's shelf life through processing changed the course of history. Today, processed food not only brings convenience to overextended families, it has become an integral part of America's social fabric. From fast food to fine dining, it's easy to understand why consumers disregard the nutritionally sound advice to avoid processed foods.

OneNumber's ability to instantly rate processed and unprocessed foods, including many restaurant menu items, eliminates all confusion. There is no longer any need to avoid processed foods. Just check their ratings and avoid those that are rated 5 and below.

How many good-to-excellent processed foods are there? The USDA National Database[10] lists more than 250,000 branded foods and private databases list even more. There are also hundreds of thousands of restaurant menu items available to us — nearly all of them heavily processed. If only one in five are nutritionally sound — and with *OneNumber* it's quick and easy to ascertain which those are — the number of wholesome processed foods in the USDA database is still an order of magnitude larger than the number of unprocessed foods. We've shown that avoiding processed foods is nutritionally sound advice but, with *OneNumber* to guide us, we can now enjoy tens of thousands of wholesome processed foods and their advantages.

Berried under the spell of marketers

Many nutritionists say that berries are good for us. Figure 17 confirms this. Berries, especially the more highly rated ones like raspberries and blackberries, are excellent sources of dietary fiber. Figure 17 also presents an opportunity to see how marketers influence our perceptions about food. Take the two extremes: blackberries and blueberries. Both are represented by growers' associations that deluge us with promotional messages showing fabulous recipes and singing the praises of their products. From this we collectively form perceptions. Though we've seen no scientific survey, we believe the general perception is that blueberries are one of the healthier berries, quite probably the best. This speaks well of blueberry growers' messaging, but what about their product? A technical comparison shows blackberries are better. Per comparable serving (Table 2 next page), blackberries (rated 20) contain twice the protein, twice the fiber, half the sugar and 26% fewer Calories than blueberries (rated 7.7).[10] This example is just anecdotal, but it illustrates how marketers can affect our perceptions. Less anecdotally, U.S. blueberry production in 2017 was 589 million pounds. Net import/exports added another 79 million pounds, bringing the total estimated national consumption to around 668 million pounds. That same year, the country produced some 75 million pounds of blackberries and imported another 188 million for a total estimated consumption of 263 million pounds, giving a relative ratio of 2.54:1.[15][16] We asked our local supermarket produce manager about the relative quantities he sells and he said the ratio is about 3:1 in favor of blueberries. On a nutritional basis, the ratio should be the reverse. Conclusion? We love our sugar, succumb to marketing, hate spitting out seeds, or perhaps all three.

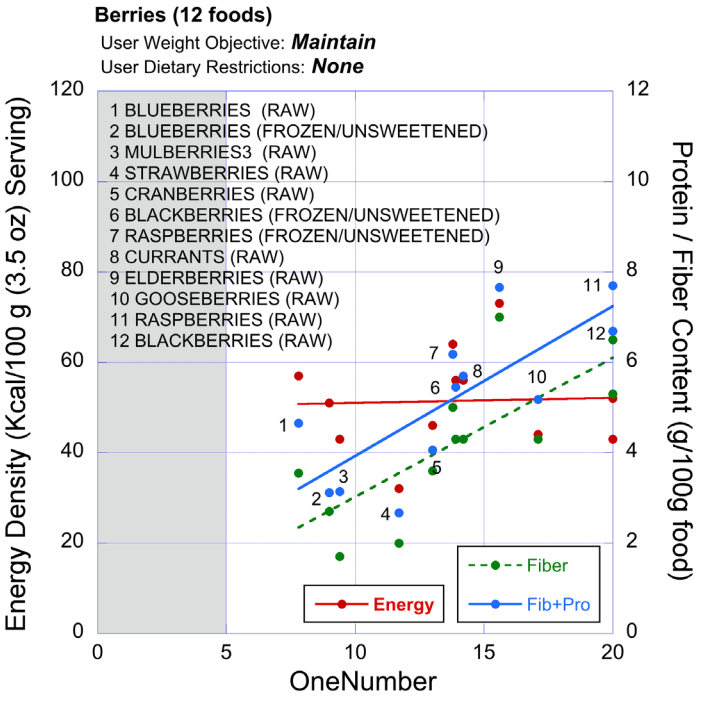

Figure 17) ***OneNumber*** **with energy density (r = 0.04, p > 0.05, N = 12, -0.544 < ρ < 0.602),** ***OneNumber*** **with fiber + protein content (r = 0.846, p < 0.001, N = 12, 0.529 < ρ < 0.956), and** ***OneNumber*** **with fiber content (r = 0.815, p < 0.001, N = 12, 0.453 < ρ < 0.946) for berries for a user with no dietary restrictions who wants to maintain weight.**

Table 1
A nutritional comparison of blackberries and blueberries
(All data except OneNumber *from Reference 10)*

	BLUEBERRIES	BLACKBERRIES
Serving size	1 cup	1 cup
OneNumber*	7.7	20
Energy (Kcal)	84	62
Protein (g)	1.1	2.0
Fat (g)	0.49	0.71
Sugar (g)	14.74	7.03
Fiber (g)	3.55	7.63

**Goal: to maintain weight with no dietary restrictions*

Legumes, including the wonder food: beans

The food group called legumes is rated highly by our nutritionists. Vegetarians and vegans value it for its many protein-rich meat substitutes. Figure 18 shows the energy and nutrient relationships for 279 legumes and legume products carried in the USDA databases.[10] It is a heterogeneous array of energy densities and nutrient contents in which the advice from nutritionists to "eat legumes" is still too broad to be very useful to the layperson.

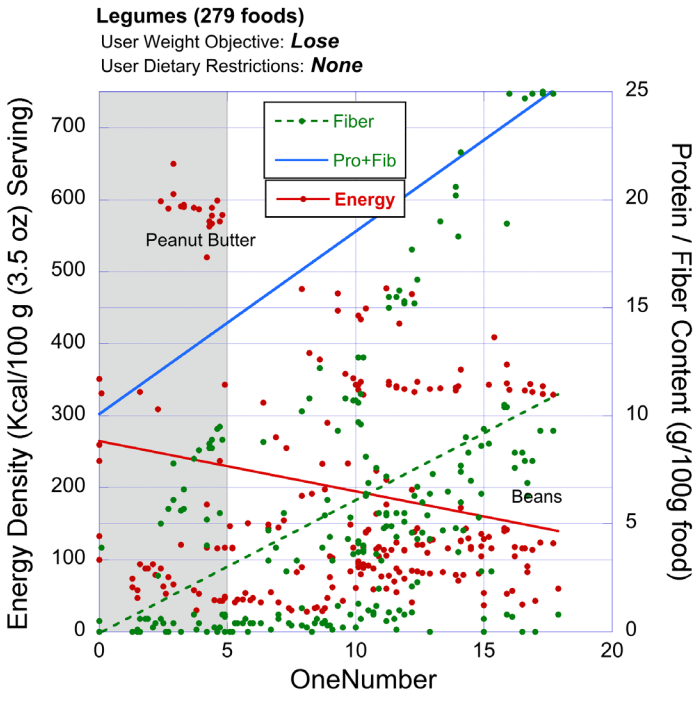

Figure 18) The relationships between *OneNumber* and energy density (r = -0.143, p < 0.05, N = 279, -0.254 < ρ < -0.028), *OneNumber* and fiber content (r = 0.498, p < 0.0001, N = 279, .406 < ρ < .580) and *OneNumber* and fiber plus protein content (r = 0.410, p < 0.001, N = 279, .309 < ρ < .502) for legumes for a user who needs to lose weight.

Let's narrow the search to a legume subgroup that has astoundingly good nutritional properties: cooked beans. This is clearly evident in Figure 19. The worst of 84 beans rates above 9 on the *OneNumber* scale for a person who wants to maintain weight, and while not one of them reaches the maximum rating of 20, many are loaded with protein and hard-to-get fiber while having moderate energy densities.

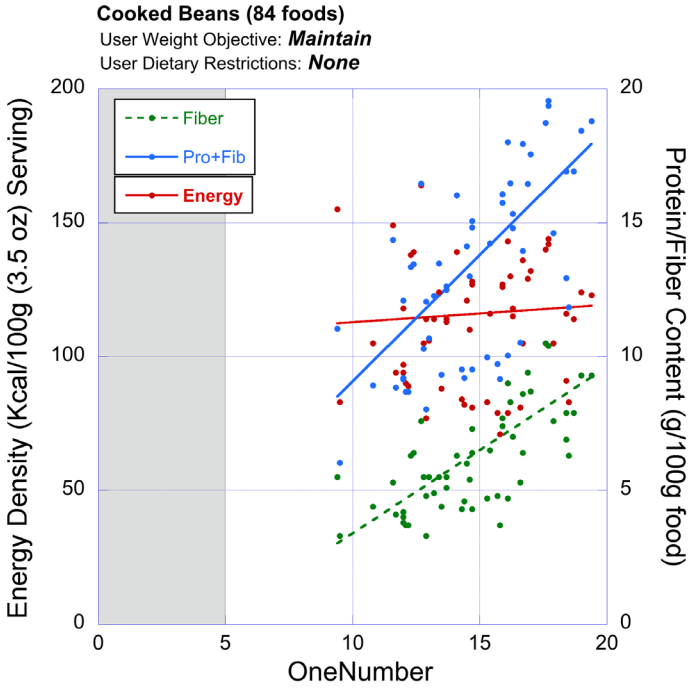

Figure 19) Cooked beans are excellent sources of protein and fiber with moderate energy densities. This figure shows energy density as a function of *OneNumber* rating (r = 0.071, p > 0.05, N = 84, -.15 < ρ < .28), the relationships between *OneNumber* and protein plus fiber content (r = 0.658, p < 0.0001, N = 84, 0.516 < ρ < 0.765) and between *OneNumber* and fiber content (r = 0.738, p < 0.001, N = 84, .622 < ρ < .822). This user has no dietary restrictions and needs to maintain weight.

Space does not permit showing every food group, but Table 2 on the following page summarizes the correlations between *OneNumber* rating of a food and its content of major macronutrient categories.

Summary

We have shown that *OneNumber* ratings inversely and often strongly correlate with the negative attributes of energy density and fat content, and directly and often strongly correlate with the positive attributes of fiber and protein content. The correlations are weaker for food groups with more type diversity, such as legume and

legume products, than for food groups with more homogeneity in food properties, like beef and beef products.

Weak and noncorrelations occur, but we find that they are either intended, as in Figures 4 and 5, or do not detract from the value of the *OneNumber* rating. For example, ratings for berries in Figure 17 if anything, show a nominally positive (though insignificant) correlation between *OneNumber* and energy density (r = 0.044). The rating equation for berries was driven very strongly by nutrient content (r = 0.755). So we can still be sure that the *OneNumber* rating is steering the user correctly. The reverse effect happens for vegetables in Figure 13. Here ratings were more strongly driven by energy density (r = -0.53) than by nutrient content which varies less over the 0-20 *OneNumber* range (r = 0.20), but again, there can be no debate that *OneNumber* is giving good advice.

We have shown that the *OneNumber* rating responds to changes in dietary restrictions as well as changes in a user's weight objective. Therefore we conclude that the *OneNumber* rating is a viable tool for directing a layperson toward foods that best serve his personal needs and away from those foods that do not.

Every food group contains some foods that are beneficial and others that are detrimental. Therefore, recommending foods by group cannot ensure that a layperson will always choose wisely; at best it merely increases the odds. In addition, a collective negative recommendation like "avoid processed foods" can deprive the layperson of the nutritional benefits and convenience of tens of thousands of wholesome processed foods. In essence, today's widely used practice of recommending (or condemning) foods by broad group classifications is of little value. It's too nonspecific to always direct a layperson away from bad choices and toward better ones, a need that is especially important to those on medically restricted diets.

Table 2
Summary correlations for the sixteen food groups in the study

*(*OneNumber *ratings calculated for weight maintenance with no dietary restrictions and correlated with the column headings.)*

USDA FOOD GROUP	SAMPLES	ENERGY DENSITY	PROTEIN CONTENT	FAT CONTENT	FIBER CONTENT	PRO+FIBER CONTENT
Nuts & Seeds	137	-0.07	0.67	-0.17	0.48	0.78
Fish & Shellfish	264	-0.70	0.26	-0.85	N/A	0.26
Legumes	288	-0.12	0.28	-0.36	0.50	0.41
Subgroup (Beans)	84	0.07	0.45	-	0.74	0.66
Snacks	175	-0.26	0.74	-0.20	0.62	0.93
Processed Meats	165	-0.79	0.57	-0.84	N/A	0.57
Beef	893	-0.84	0.45	-0.94	N/A	0.45
Meals	81	-0.50	0.01	-0.13	0.27	0.08
Lamb	461	-0.82	0.50	-0.87	N/A	0.50
Baked Products	515	-0.45	0.68	-0.52	0.80	0.86
Breakfast Cereals	191	-0.13	0.64	0.17	0.83	0.82
Poultry	383	-0.85	0.55	-0.89	N/A	0.55
Vegetables	767	-0.48	0.04	-0.33	0.15	0.12
Cereal Grains	166	-0.07	0.43	0.17	0.76	0.76
Pork	336	-0.81	0.50	-0.84	N/A	0.50
Dairy & Egg	264	-0.20	0.54	-0.38	N/A	0.55
Fruits	111	-0.22	0.10	0.03	0.66	0.59
Subgroup (Berries)	12	0.04	0.39	-	0.82	0.85
ALL PLANT	2386	-0.52	0.1	-0.37	0.29	0.21
PLANT & ANIMAL	5257	-0.62	0.41	-0.45	-0.04	0.40

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Appendix

Data sources

Food nutrient and energy data used in this study are from USDA databases (Reference 10) for 16 different food groups. Foods included may be either unprocessed (as blackberries, raw) or processed (as bratwurst, chicken, cooked). Branded processed products also appear. The 16 food groups, totaling 5257 separate food descriptions, are given in Table 2.

Note on data exclusion

Every item in every group was included in the analysis and presentation unless:

- the entry had an obvious error, such as a missing field,
- the food was listed in the wrong group, e.g. beef sausage in the fruit group,
- we judged that the food was rarely eaten and including its data would have degraded the presentation for more commonly consumed foods.