Nutrition intake during long distance paddling events

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Introduction

The ultra endurance paddle athlete must meet the constant energy demands of exercise through continuous consumption of foods and fluids over prolonged periods of activity. However, current nutrition recommendations for endurance athletes do not specifically address the needs of the paddle athlete. Given the increased participation and number of ultra distance paddling and adventure competitions around the world, the need for such nutrition recommendations is compelling. The current recommendations may not adequately address the needs of the ultra endurance paddler for several reasons. First, these recommendations are based on cycling or running exercise performed continuously up to five hours. Second, additional challenges come with ultra endurance events such as long periods of sleep deprivation, competition in the dark and wide variations in weather-related conditions. And third, the paddle athlete is met with unique challenges such as continuous upper body movement, required boat skills and marine-related hazards. These challenges can affect the safety of the athlete and his or her ability to consume adequate calories. Combined with the fatiguing effects of continuous exercise that can be strenuous at times, these factors make the nutritional component of the paddle athlete's competition even more critical.

The purpose of this exploratory study was to quantify the energy nutrient intake during ultra distance (> 60 miles) paddling events. The project goal was to study the nutritional strategies currently used by ultra distance paddle athletes. While this study is observational in nature, the information gathered will initiate a long term project to study nutrition and energy balance as they relate to performance and health of ultra endurance paddle athletes.

Data for this report were gathered from three races, MR 340 (August 2010), the Everglades Challenge (March 2011) and the Ultra Marathon that coincided with the Everglades Challenge. Here is a brief description of each race:

MR 340. The MR 340 is the longest river race in the United States at approximately 338 miles between Kansas City and St Charles on the Missouri River. The 2010 race was postponed from its earlier July date due to high water levels. During the race, water levels approached flood stage and consequently the water current was faster than usual. As a result, many records were broken, including women's solo, women's tandem, men's tandem and mixed tandem. Temperatures were mild, in the 70s and 80s during the day and 60s at night and very little wind. During the early morning of the second day, dense fog covered the area, delaying some paddlers. The challenge of paddling this river is primarily to avoid the objects above and below the water surface such as wingdams (which may not be exposed at high levels), large metal buoys, barges and other motor boats. Strong reverse hydraulics is created by some of these objects especially at high water levels and multi-foot wide whirlpools that come and go are not unusual.

Everglades Challenge. This race is approximately 270 to 300 miles depending on the specific route chosen by the athlete. This is not only a test of endurance but a test of navigational skills as a significant portion of the race passes through wilderness areas of the Everglades National Park. Tide and wind conditions greatly dictate the paddler's route and race time and can dramatically affect water levels in shallow areas such as Florida Bay. During the 2011 race, paddlers were challenged remarkably from the persistent high wind conditions. The race began on March 5 and during the first two days headwinds of 20-25 mph challenged the paddlers as they made their way south along the gulf coast. On day 6, a strong northerly front swept in 32-36 mph winds at midday, bringing rain and cooler temperatures. After that, north winds continued at a sustained 20-25 mph the next day. This was the toughest race in history for the Everglades Challenge; 74 boats began, 30 finished.

Ultra Marathon. The Ultra Marathon athletes begin their competition alongside the Everglades Challengers. The distance is the first leg of the Everglades Challenge that ends at checkpoint 1; approximately 67 mile from the start. The Ultra Marathon athletes covered the distance with continuous headwinds above 20 mph.

Methods

Each athlete kept a record of foods and fluids that were consumed during the entire race. The amount of detailed information provided fairly accurate estimations of total calorie and macronutrient intakes. For the most part, all foods and fluids consumed were carried on the boat at the start of the race. The quantities of foods and fluids at the beginning and at the end of the race were reported. For this report, the focus was specifically on calories and the energy nutrients consumed from start to finish. Calories and macronutrient content were determined from food labels obtained from specific brand websites and the USDA nutrition database.

Calorie and macronutrient intakes are reported in total, amounts per day and amounts relative to body weight. Percent of calories from carbohydrate, total fat and protein were also calculated. Depending on the race and the athlete, other specific information was gathered. Macronutrient information included carbohydrate (C), protein (P) and total fat (F).

The MR 340 results

Two athletes (athlete 1, male, 74 kg; athlete 2, female, 57 kg) provided nutritional information. Athlete 1 completed the race in approximately 47 hours, with 40 ½ hr paddling time. He stopped twice and slept approximately 5 hours. Athlete 2 completed the race in 58 hours, consisting of about 46 paddling hours. The athlete made two stops and slept approximately 7 hours (some delay due to dense fog).

Athlete 1 consumed about 6400 calories and approximately 45% of these came from a dairy-based nutrition drink and 31% from a specific brand of energy bars. Total fluid consumption is unknown but the athlete did consume 3 liters of fluids containing calories. Total calorie consumption for athlete 2 was about 6200 calories; 46% from a carbohydrate-protein sport drink. A carbohydrate-electrolyte sport drink and bananas contributed about 22% and tuna sandwiches about 10% of calories. Fluid consumption was approximately 14 oz (.4 liters) per hour. A summary of nutrition for both athletes is presented in Table 1 below. Because both athletes consumed a relatively small quantity of calories during rest periods, intake per hour of paddling was included in the information. Figure 1 below illustrates the percent of calories that came from each macronutrient. Athlete 1 reported having lost about 2 lb body mass and athlete 2 gained about 1 lb.

Table 1. Nutrient intake during the MR 340 for athlete 1 and 2.

		Calories	C (g)	F (g)	P (g)
1	Total	6440	975	188	212
	per day	3269	495	95	108
	per kg/day	44.1	6.7	1.3	1.5
	per hour*	159	24.1	4.6	5.2
2	Total	6207	1262	88	132
	per day	2576	524	37	55
	per kg/day	45.4	9.2	0.6	1.0
	per hour*	136	27.7	1.9	2.9

** based on hours spent paddling. C = carbohydrate, P = protein, F = total fat.*

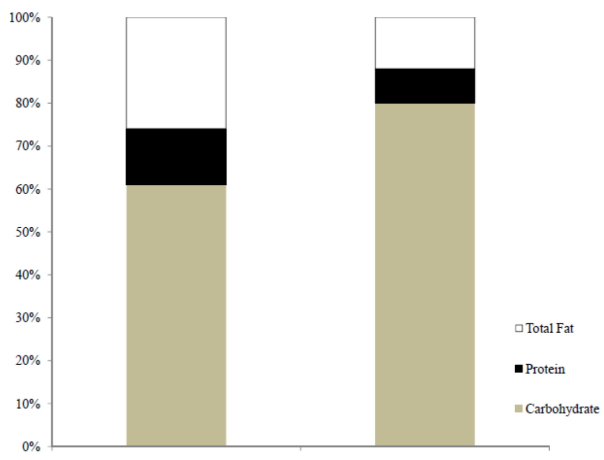

Figure 1. Percent calories from macronutrients during the MR340 for athlete 1 and 2.

The Ultra Marathon results

Four male athletes and one female athlete provided nutrition information. Four athletes competed in the Ultra Marathon and one athlete competed in the Everglades Challenge but did not continue past the end point for the Ultra

Marathon. The male athletes competed in the men's single boat division (class 1 or 2) and the female athlete competed in the double mixed division (class 1). Both average and individual values are reported.

Table 2 below provides information concerning the athletes' food and water quantities that were carried on the boat. Note that athlete 3 carried a much greater quantity, in preparation for the longer distance. Average fluid intake per hours was calculated based on beginning and end water weight and estimated total paddle time. Table 3 provides calorie intake information for these athletes. The data include the average for male athletes. Note that the female athlete consumed 44% more calories than the males. This approximated to almost twice as many calories per kg of body mass. However, when calorie intake was adjusted according to total hours of paddling, the female athlete's intake was similar to the males. The greatest difference is between M1 and the other athletes, likely attributed to M1's greater body mass and thus, greater calorie requirements. This is evident from the remarkably similar calorie amounts consumed by these men when adjusted to body mass.

Figure 2 below illustrates the hourly carbohydrate intake for each athlete. The current recommendation for carbohydrate intake during an endurance event is 0.7 g/kg per hour. None of the athletes achieved the recommendation. The highest carbohydrate intake was observed in M1; however his consumption (0.30 g/kg/hr) was only 43% of the recommended. Intake among the other athletes ranged from .18 to .25 g/kg/hr. Another way to evaluate the athletes' carbohydrate intake is the total amount consumed, including pre-race intake relative to body mass. The minimum recommended daily carbohydrate intake for an endurance athlete is 6.0 g/kg. Among the male athletes, M1 consumed 6.0 g/kg; however the other male athletes did not meet the recommendation with carbohydrate consumptions ranging from 5.4 to 5.6 g/kg. The fact that M1 consumed the most carbohydrate relative to body mass is noteworthy given his faster paddle time. Also noteworthy is the female athlete's carbohydrate intake of 9.0 g/kg, more than 50% higher than the average male athlete intake.

Table 2. Quantities of food and fluids carried during the Ultra Marathon race.

Athlete	BW	Total paddle time, hr	Beg food, lb	End food, lb	Beg water, liter	End water, liter*	Water intake, liters per hr
1	93.6	17.2	3.2	1.6	18.3	3.1	.9
2	79.5	19.9	3	2.3	23.1	9.25	.7
3†	84	25.5	14.9	13.1	12.4	6.2	.2
4	84	24.5	4.5	3	36	12.4	1.0
5‡	63.6	22.4	4.9	3.1	16.4	6	.5
Average	80.9	21.8	6.1	4.6	21.2	7.4	.7

† participant 3 competed in the Everglades Challenge, but did not continue past checkpoint 1.

‡ female athlete.

Table 3. Calorie intake during the Ultra Marathon race.

Athletes	Total Calories	Total Calories per kg	Pre-race Calories*	Race Calories	Calories per hour†
M1	3060	32.7	450	2610	147.5
M2	2620	33	420	2200	109.5
M3	2733	32.5	0	2733	97.6
M4	2962	35.3	440	2522	95.2
M avg	2844	33.4	328	2516	112.5
F	4100	64.5	800	3300	120.4
Avg	3095	39.6	422	2673	114.0

** pre-race = within 4 hours prior to the start of the race. † Based on race calories. C = carbohydrate, P = protein, F = total fat. M1 – M4 are individual male athletes. M avg is the average of male athletes. F is the female athlete. Avg is the average of all athletes.*

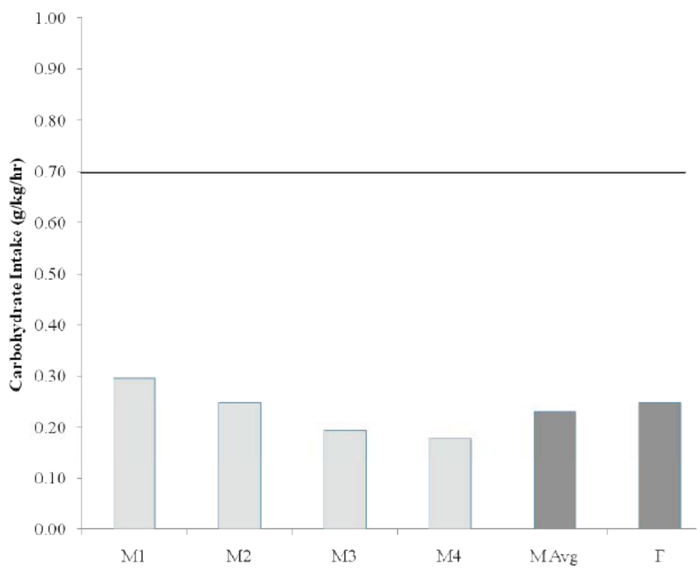

Figure 2. Carbohydrate intake per kg body mass per hour during the Ultra Marathon. M1 – M4 are individual male athletes. M avg is the average of male athletes. F is the female athlete. The horizontal line represents the minimum recommended carbohydrate intake based on ACSM's 2009 *Nutrition and Athletic Performance* Position Stand.

Figure 3 below illustrates the protein intake for each athlete. Currently, there are no recommendations for protein intake during an endurance event; although evidence suggests that some carbohydrates can be replaced with protein without a compromise in performance. The only recommendation for protein intake concerning the endurance athlete is to consume 1.2 to 1.4 grams per kg body mass per day, in comparison to the 0.80 g/kg RDA for healthy adults. Consequently, the protein intakes of the Ultra Marathon athletes are compared to this recommended range of intake, as shown in Figure 3. As can be seen, protein intake varied greatly among the athletes. It should be noted that these intakes are based on the time spent paddling and not a 24-hr time period. For instance, if the female athlete's protein intake is adjusted for a 24-hr period, it is reduced to 1.5 g/kg/day because her official race time was greater than 24 hours.

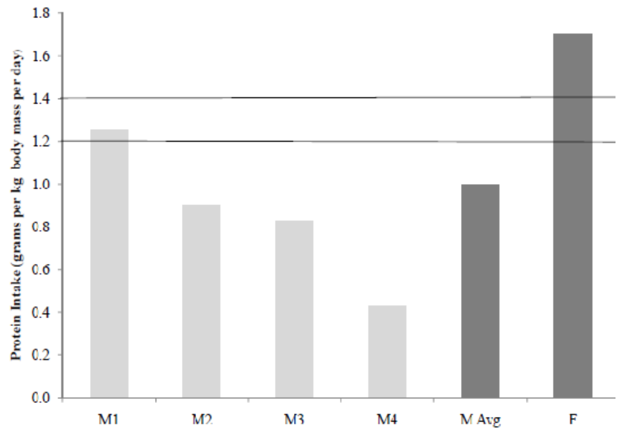

Figure 3. Protein intake per kg body mass per day during the Ultra Marathon. M1 – M4 are individual male athletes. M avg is the average of male athletes. F is female athlete. Horizontal lines represent the minimum and maximum recommended protein intake based on ACSM's 2009 *Nutrition and Athletic Performance* Position Stand.

The difference between the male athletes and female athlete regarding calorie intake is striking; however, this difference is easily explained by the fact that the female athlete was paddling in tandem and stopped to rest for several hours during the race. It is likely that this allowed her more opportunities to consume calories, thus explaining the very high calorie intake compared to her male counterparts that were paddling solo. Another observation concerns the difference in calorie sources among the male athletes. In particular, the two fastest male athletes acquired 100% of calories from sport/nutrition beverages, energy bars and sport gels; whereas the other two males acquired 30% and 50% of calories from other types of solid foods such as bread, cheese, dates and peanut butter. Although total calories did not differ remarkably among these athletes, it is quite possible that the faster athletes consumed calories more frequently and required less stop time to do so.

The Everglades Challenge results

Two athletes (both males; body masses 76 kg and 95 kg) that completed the Everglades Challenge provided nutritional information. Both athletes planned out a race menu ahead of time and carried most of the calories consumed in the boat from the beginning. Foods were picked up along the way but amounted to only 6.6% and 10% of calories for athlete 1 and 2, respectively. Athlete 1 completed the race in approximately 108 hours (4 ½ days) and athlete 2 completed the race in approximately 147 hr (6 days). Total paddle time for athlete 1 was 75.25 hours, averaging 16.1 hr per day during the first four days of the race. Total paddle time for athlete 2 was 83.5 hr, averaging 12.7 hr per day during the first 6 days of the race. The longest paddle day for athlete 1 was day 3 at 18 ½ hr. Average stop time was 6 ½ hr per day and total paddle time was approximately 69% of official race time. Athlete 2 paddled 19.5 hr the first day and averaged about 11 hr per day over the next five days. Average stop time was approximately 10 hr per day, and total paddle time was approximately 57% of official race time.

Table 4 below provides the calorie intake information for the two athletes. Although daily carbohydrate intake was similar between the two when expressed relative to body mass, calorie, fat and protein intakes were higher in athlete 2. This could be attributed to athlete 2's longer time off the water and greater amount of calories obtained from purchased food items at the checkpoints. Noteworthy is that both athletes reported having lost at least 5 lb of body mass during the race (based on pre and post body weight measures). This appears reasonable given the relatively low intakes. The current recommendation for daily carbohydrate for an endurance athlete in training is 6-10 g/kg and when in competition, it is greater than 10 g/kg/day. As mentioned earlier, the current daily recommendation for protein is 1.2 – 1.4 g/kg. Neither athlete met the carbohydrate recommendation. Athlete 1 did not meet the protein recommendation.

Table 4. Nutrient intake during the Everglades Challenge.

		Calories	C (g)	F (g)	P (g)
1	Total	11432	1703	350	400
	per day	2286	341	70	80
	per kg/day	30.1	4.5	1.1	0.9
	% calories		59	27	14
2	Total	20754	2586	743	932
	per day	3380	421	121	152
	per kg/day	35.6	4.4	1.3	1.6
	% calories		50	32	18

C = carbohydrate, F = total fat, P = protein.

Athlete 1's diet was consistent from day to day. With the exception of a food item consumed the morning of the first day and another on the final day, his intake included only foods and beverages carried on board. 40% of total calories were obtained from a dairy-based nutrition drink and 20% from a brand of energy bars and gel packets all consumed while paddling. 15% of calories were derived from a brand of freeze-dried packaged meals.

Athlete 2's diet was consistent on most days but fluctuated dramatically on days 4 and 5. Thus, his day-to-day nutrient intake deserves additional attention. Approximately 41% of calories were obtained from a combination of sport drinks, gels and bars, specifically designed to replace carbohydrate. Freeze-dried meals comprised 9% of the total and the remaining calories came from various snack items, foods purchased at checkpoints and a dairy-based nutrition drink. Figure 4 below illustrates athlete 2's calorie intake for each day. Compared to the first three days that were consistent, calorie intake on day 4 was considerably higher. Distance paddled that day was lower than each of the first three days and the athlete was off the water earlier than usual. Additional foods were consumed at the checkpoint rest stop and account for approximately 920 calories or 21% of the total calories consumed that day.

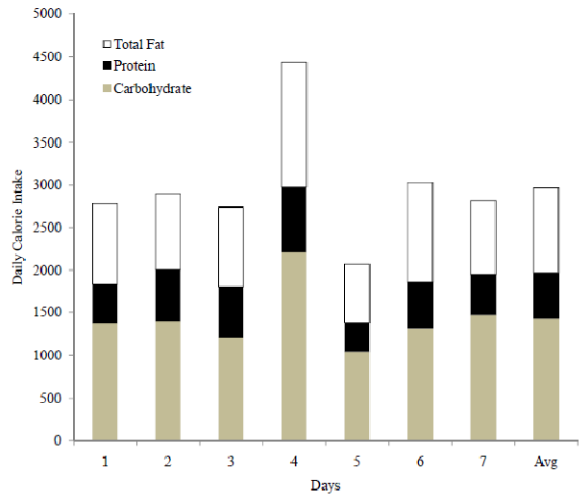

Figure 4. Daily calorie intake for athlete 2 during the Everglades Challenge, showing proportion of contribution from macronutrients. Avg = the average of 7 days.

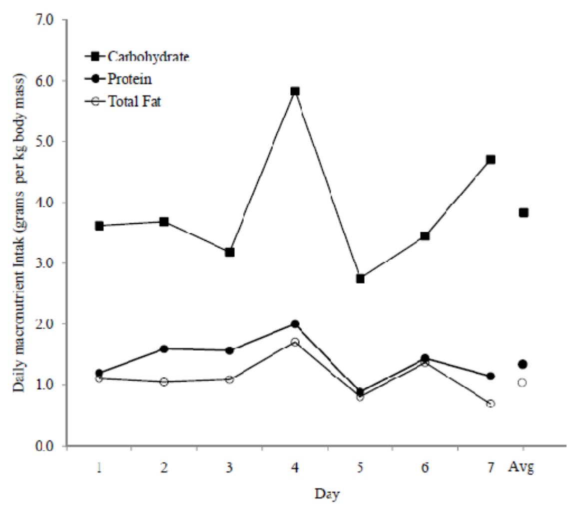

Figure 5. Daily macronutrient intake adjusted for body mass for athlete 2 during the Everglades Challenge. Disconnected data points are the average values for 7 days.

Figure 5 above illustrates athlete 2's macronutrient intake for each day. The pattern demonstrated by the carbohydrate intake parallels that of total calorie shown in Figure 4. During the final day's paddle, carbohydrate intake increased again above average, despite their being no significant increase in calorie intake. One possible reason is that this particular day was difficult with consistent headwinds in open water; in fact, the athlete commented that this was perhaps the most difficult day of the race. Thus, it makes sense that carbohydrate intake would be above average, keeping up with the relatively high paddling effort required to finish the race.

Comparing the MR 340 and Everglades Challenge

Like apples to oranges, it is difficult to compare these two races given the significant differences between them. However, the MR 340 and Everglades Challenge races are similar in distance and lending credibility to the comparison is that athlete 1 from the MR 340 is also athlete 1 in the Everglades Challenge. Table 5 below is the nutrient intake for athlete 1 during both races. The most appropriate way to compare the races is to examine daily intakes rather than total intakes given the 60-hr difference in race times. Over the course of the MR 340 race, the athlete consumed approximately 50% more calories than during the Everglades Challenge. This is noteworthy given the relative time spent paddling during each race. During the MR 340, the athlete's down time was less than 14% of total race time, while during the Everglades Challenge, down time comprised 31% of total race time. Possibly contributing to the athlete's lower calorie intake during the Everglades Challenge were the more challenging paddle conditions encountered, thus, making it more difficult to consume foods while paddling. It would seem however, that the increased effort during paddling would increase the drive to consume calories during the rest stops. But this does not appear to be the case. Unlike the MR 340, the Everglades Challenge is unsupported, meaning athletes must acquire and prepare their own food along the way. This and the fact that athletes had long days of paddling in difficult marine conditions most likely made food consumption difficult and less appealing upon stopping for the night.

Table 5. Comparing two races completed by one athlete.

		Calories	C (g)	F (g)	P (g)
MR 340	Total	6440	975	188	212
	per day	3269	495	95	108
	per kg/day	44.1	6.7	1.3	1.5
	% calories		61	26	13
EC	Total	11432	1703	350	400
	per day	2286	341	70	80
	per kg/day	30.1	4.5	1.1	0.9
	% calories		59	27	14

Also noteworthy from Table 5 is that despite the differences in quantities, the two races were similar regarding relative macronutrient contents. This can be attributed to the athlete's regimen of intake which was similar between the two races. Only one difference stands out and that is the inclusion of freeze-dried meals during the Everglades Challenge. Other than this one item, foods and beverages packed for each race were identical.

Meeting the Current Recommendations

The current calorie and macronutrient recommendations set forth by the American College of Sports Medicine and American Dietetic Association that are most relevant to these athletes are as follows:

- Carbohydrate recommendations for athletes range from 6 to 10 g/kg body mass per day. The amount required depends on the athlete's total daily energy expenditure, type of sport, gender, and environmental conditions. During training or competition of 4-6 hr or more a day, the requirement is 10 to 12 g/kg or higher per day.
- Protein recommendation for endurance athletes ranges from 1.2 to 1.4 g/kg body mass per day. Ultra-endurance athletes who engage in continuous activity for several hours or consecutive days of intermittent exercise should also consume protein at or slightly above 1.2 to 1.4 g/kg/d.
- Fat intake should range from 20% to 35% of total energy intake.
- For events lasting > 1 hr, consume 30-60 g per hour carbohydrate (or 0.7 g/kg body mass/hr). Carbohydrate intake should begin shortly after the onset of activity and occur every 15-20 min throughout exercise to meet the recommended amount.

Table 6. Comparison of each athlete's intake to the minimum daily recommendations for endurance athletes.

Race	Athlete	Calories Per kg	C g/kg	P g/kg	F % Cal
Minimum Daily Recommendation		45	6	1.2	20
MR 340	1	44.1	6.7	1.3	26
	2	45.4	9.2	0.6	12
UM	M1	32.7	6.0	0.6	15
	M2	33	5.6	0.8	22
	M3	32.5	5.4	0.8	21
	M4	35.3	5.4	1.1	29
	F	64.5	9.0	2.2	22
EC	1	30.1	4.5	1.1	27
	2	35.6	4.4	1.3	32

How do our athletes compare overall to these recommendations? Table 6 above provides information from all athletes. These data demonstrate that it is more common for paddling athletes to fall short of the recommendations. An interesting observation is the calorie, carbohydrate and protein intake of the two female athletes, compared to the males. A simple explanation for this is that the smaller body masses of the female athletes improved their ability to meet the calorie requirements of paddling.

Meeting the calorie requirements of the race

Although the athletes in this report fall short of the current recommendations for endurance athletes for the most part, the question remains as to whether or not these athletes are replacing adequate calories. In order to determine this, we must account for calorie expenditure during long distance paddling. A thorough review of calorie expenditure during kayaking and canoeing is provided in another report. From that report, it was estimated that ultra distance paddling events require approximately 35-45% of aerobic capacity (VO_2max). Because the aerobic capacities of these athletes are unknown, some assumptions were made. Elite male and female kayak athletes that train for Olympic-style events (short power distances) have VO_2maxes ranging from 50-60 ml/kg/min and 45 to 50 ml/kg/min, respectively. It can be assumed that the athletes in this study are below these values due to level of competition and training experience, and age. The ages of the athletes in this report varied; however the youngest was 38 yrs of age, while three of the athletes were between the ages 63 and 65 yr. Age-related decline in VO_2max is about 5-10% each decade past 30 yrs of age. Thus, on average, the VO_2max associated with kayaking is estimated to be approximately 34 ml/kg/min for this group. Based on estimations of calorie expenditure during ultra distance paddling, calorie expenditure was estimated for the Ultra Marathon athletes (Table 7). Because these athletes completed the distance non-stop for the most part, estimation are more accurate compared to the multi-day races.

Table 7. Estimated calorie expenditure and percent of these calories replaced by calories consumed.

Athlete	Calories expended per hr	Total calories expended	Total calories consumed	Percent replaced
M1	383	6593	3060	46
M2	326	6462	2620	41
M3	344	8771	2733	31
M4	344	8428	2962	35
M avg	349	7599	2844	37
F	229	5834	4100	70
Avg	325	7255	3095	43

M1 – M4 are individual male athletes. M avg is the average of male athletes. F is the female athlete. Avg is the average of all athletes.

From the data shown in the table, the male athletes replaced on average less than 40% of calorie expenditure, with the greatest amount replaced by the female athlete. Overall, the low intake among these athletes can be partially attributed to the difficult marine conditions that were encountered during the entire race. However, it is noteworthy that despite the marine conditions and the unique challenge of consuming calories while engaging in continuous upper body exercise, these athletes managed to consume a good amount of calories.

Practical Applications and Summary

Main points

- During long distance paddling, frequent short breaks (1-3 per hour) for calorie and fluid consumption is preferable. Consumption during these short breaks may be as little as a few bites of energy bar, 8 oz of energy drink or a gel pack to as much as an entire energy bar, an 8 oz container of dairy-based nutrition drink, or 24 oz bottle of an energy drink.
- For the single-day race athlete, energy bars, sport gels and sport drinks that exploit the benefits of carbohydrate more than protein are preferable.
- For the multi-day race athlete, beverages and energy bars that provide significant carbohydrate and moderate levels of protein and fat are preferred over those that include no more than a few grams of protein or fat, if they can be tolerated while paddling.
- Once sweat rate is determined, an athlete can estimate an adequate amount of fluids to consume during a race by adjusting according to environmental conditions.
- Electrolytes can be obtained as long as the athlete adequately replaces fluids with a combination of sport drinks and plain water while consuming foods.
- Nutritional training is necessary to meet the following objectives; find the right combination of foods and beverages that allow frequent consumption without significant hindrance to paddling, minimize food burnout, and obtain adequate intake of macronutrients to support optimal performance and adequate recovery.

Ultra distance paddle athletes are uniquely challenged

Nutritionally speaking, it appears that one of the biggest challenges to the ultra distance paddler is obtaining calories and fluids; which if not done adequately, can have negative consequences on performance and recovery. Marine conditions and other open-water hazards may preclude these athletes from consuming adequate calories as often as needed to optimally sustain a moderate to moderately high level of exertion for several hours. Thus, it is likely that the paddler's ability to achieve optimal performance is significantly dependent upon his or her ability to overcome the nutritional challenges of obtaining adequate calories and fluids.

Previous studies indicate that cyclists performing > 20 hr of continuous cycling replace 54 to 77% of calories expended. On the other hand, athletes competing in multi-sport events that include running or hiking and swimming tend to replace fewer calories (36 to 44%). By nature of the upper body movement of his or her sport, the paddler will also replace fewer calories than the cyclist. The paddler cannot maintain a pace while consuming calories; in fact the only calories that could be consumed without breaking stride would be through a hydration system such as a *Camelbak.* The data presented in this report support the idea that the paddling athlete is likely limited in the ability to replace calories by nature of the activity. Therefore, the challenge for the ultra distance paddler is to come up with strategies to help overcome these limitations as best as possible.

Practically speaking, the ultra distance paddler must approach his or her calorie consumption and rehydration with the intention of taking several short breaks that allow him or her to consume calories and fluids on a regular basis. In theory, the short time it takes to consume 8 oz of fluid or an energy bar will be made up by the faster paddling speeds and overall better performance. A hydration system that includes calories would be most beneficial as the athlete can consume calories without stopping. However, some paddlers, especially during multi-day races are less inclined to use these systems for sugar-containing fluids because of the risk of mold and bacteria. For these athletes, fluids stored in containers that can be kept inside the cockpit would be necessary.

Choosing the right foods and beverages

Because calorie consumption poses a challenge to the paddler, choosing the right foods and fluids is a critical consideration. Specifically, the athlete must acquire adequate carbohydrate to sustain the energy levels required while also obtaining the daily requirements for other nutrients including essential fats and proteins. Finding food and beverage items that can meet these requirements, fit the athlete's taste preferences, and are palatable and relatively easy to consume and digest while paddling takes several trials. In addition, the athlete must consider variety as a possible essential component to his or her nutrition, particularly during multi-day paddle events.

From information gathered here, it appears that calorie-containing beverages, energy bars and gels are preferred by these athletes. Particularly noteworthy is the consistent use of sport drinks and energy bars that contain significant carbohydrate calories but also moderate amounts of fat and protein. For multi day events, these items may be the best way to obtain the necessary nutrients, including carbohydrate. For a comparison, five beverages are presented in Table 8 below. Note that the carbohydrate amounts are similar, despite their being a wide variability in calorie density. Total fat content contributes significantly to the calorie density. However, the calorie density of the powdered drink mixtures depends on the amount of added water. For instance, if half the recommended volume for Hammer Perpetuem powder is used, rightly so the calorie density is doubled.

Table 8. Comparison of calorie density (calories per oz) and sources of calories among five nutrition and sport drinks.

	Volume	Calories	Calories per oz	Carb (g)	Total Fat (g)	Protein (g)
Ensure Boost Plus†	8 oz	360	42.6	45	14	14
Nestle Boost Energy†	8 oz	240	29.6	40	4	10
PacificHealth Endurox R4*	12 oz	270	22.5	52	1	13
Spiz energy drink*	24 oz	260	10.4	47	2.5	10
Hammer Perpetuem*	32 oz	270	8.0	54	2.5	7

** 2 scoops powder added to the recommended volume. † Ready mixed and provided in plastic bottles. Carb = carbohydrate*

Energy bars and sport gels are also commonly used among paddlers. There is a large variety of energy bars and quite possibly the decision to use a particular bar is primarily based on taste preference and ease of consumption and digestion and not as much on the specific nutrient content. However, because some energy bars vary significantly from one another, there are characteristics that the athlete should be mindful of when choosing the right ones. To describe these characteristics, data were obtained from 116 bars (including 5 traditional candy bars). Not surprising is the strong relationship between calorie density of energy bars and percent of calories coming from total fat (R = .89), given that the energy yield from fat is twice that of carbohydrate or protein (similar to the beverages listed in Table 8). It may seem that the addition of fat would compromise the amount of carbohydrate and/or protein in the bar, but this does not seem to be the case; rather, there is a large variability in carbohydrate and protein contents at a given percentage of fat content. This pattern also holds for the beverages described above. What this means to the athlete is that he or she can choose an energy bar or beverage primarily for its carbohydrate or protein content and consider fat content simply for added calories. An example of how this works is by comparing the following two bars that provide similar carbohydrate and protein but yield very different calorie and total fat contents:

PowerBar Harvest Energy Apple Cinnamon Crisp; 240 calories, 42 g carbohydrate, 4g fat, 10 g protein

Pro Bar Sweet & Savory Cocoa Pistachio, 390 calories, 42 g carbohydrate, 22 g fat, 11 g protein

Single day vs multi-day race nutrition

Choices of foods and beverages should differ somewhat between the multi-day and single-day race athlete. Table 9 below illustrates these differences by providing an example of calorie consumption during five hours of non-stop paddling. With the goal of consuming 25-30 g carbohydrate per hour, each athlete chooses a combination of beverage, energy bar and gel to reach it. While both are able to achieve the carbohydrate goal, differences between the two are the number of calories, total fat and protein consumed. The idea is that the single-day athlete is achieving his or her nutrition goal to sustain performance only until the end of the race. For this athlete, energy bars and sport drinks that exploit the benefits of carbohydrate more than protein will prove beneficial. Protein can at least replace some of the carbohydrate but it should not be the primary macronutrient for this athlete. For taste preferences, a combination of energy bars and beverages where some contain low to moderate amounts of protein and fat may be beneficial in order to keep up the frequent intakes. Sport gels can add additional quick carbohydrate calories. It would be essential that the athlete experiment with various types of beverages and foods in order to find those that are best tolerated and can be consumed frequently with ease.

During multi-day races, the first calorie priority is carbohydrate and the second is protein. However, in addition to maintaining optimal performance while paddling, the multi-day race athlete must consider the next day’s paddle which will follow a very short recovery period. Thus, in order to maintain performance over several days, the multi-day athlete must supplement his or her recovery periods by consuming as many calories as possible while paddling. To do this, high calorie dense foods containing moderate fat content must be included. Compared to the single-day race, beverages and bars that provide significant carbohydrate and moderate levels of protein and fat should be preferred over those that include no more than a few grams of protein or fat, if they can be tolerated while paddling (refer to Table 9 for examples). Energy bars that include high amounts of nuts generally provide the greatest amount of fat and calories, but the athlete must be sure that he or she can tolerate the added fiber content. Additional carbohydrate can be consumed through a sport drink or gel. During recovery, obtaining additional protein and fat is important; however, it is essential that the athlete replace his or her carbohydrate stores. Thus, high calorie dense foods that contain the greatest proportion of calories from carbohydrate are important for adequate recovery. Another beneficial feature of an energy bar worth noting are the RDA percentages and number of vitamins and minerals added to the bar. Some bars include large percentages (> 30%) of several vitamins and minerals, many do not.

Table 9. An example of foods consumed during a 5-hr period of non-stop paddling, during a multi-day race and single-day race.

	Description	Calories	Carb (g)	Total Fat (g)	Protein (g)
Multi-day race	Hammer cashew coconut chocolate chip bar	230	27	11	5
	Clif carrot cake bar	240	46	4	10
	Nestle Boost, 8 oz bottle	360	45	14	14
	GU energy gel pack	100	25	0	0
	Average per hour	**186**	**28.6**	**5.8**	**5.8**
Single-day race	PacificHealth Accelerade Hydro, 3 scoops in 4.5 cups water	150	30	0	7.5
	2 Hammer energy gel packs	200	50	0	0
	PowerBar Performance chocolate bar	240	45	3	8
	Nature Valley granola bar	95	14	3.5	2
	Average per hour	**137**	**27.8**	**1.3**	**3.5**

Although the greatest proportion of calories seems to come from nutrition/sport drinks, and energy bars and gels, other food items may also be useful, particularly for the multi-day paddler that might stop for several hours at a time and may have opportunities to acquire foods at checkpoints. If this is the case, the athlete is encouraged to experiment with foods prior to the race and test them for several qualities including palatability, ease of consumption, preparation time and effort, variety and storage durability. Challenging marine conditions will likely increase the athlete’s level of exhaustion at the end of a 15-20 hr paddle day, thus making it all the more difficult to acquire calories before attempting to sleep. The athlete should experiment prior to a multi-day race with foods to test their ease of preparation and consumption and choose a variety of palatable ready-to-eat foods and beverages that can be consumed upon stopping to camp or rest for several hours.

Fluids and electrolytes

While the focus of this report is on calories and macronutrients, some mention to the importance of fluids and electrolytes should be given, especially when making food choices. Generally, sport drinks and energy bars provide adequate amounts of sodium and potassium, the two primary electrolytes lost through sweating. Thus, when choosing a food or beverage item, electrolyte content should not be the primary consideration. However, replacing fluids lost is an important concern to the athlete. The athlete can easily determine his or her fluid requirements by estimating sweat rate. This can be done by measuring body weight before and after a training session, with consideration to environmental conditions. When doing so, account for total intake during the paddle (one liter of fluid is equivalent to 2.2 lb (1 kg) of body weight). For instance, assume a body weight decrease of 1 lb following 3 hours of paddling during which 2 liters of fluid and 5 oz of food (about 150 grams) were consumed. In weight, this is approximately 4.7 lb (2.1 kg) consumed. Add that amount to the 1 lb (.5 kg) body weight loss and the calculated total amount of sweat loss is 5.7 lb (2.6 kg). That is equivalent to about 2.6 liters of fluid or just under 1 liter per hour of paddling. Once sweat rate is determined, an athlete can estimate an adequate amount of fluids to consume during a race by adjusting according to environmental conditions. Electrolytes are almost always included in sport drinks, nutrition drinks and foods; thus, as long as the athlete is adequately replacing fluids with a combination of sport drinks and plain water while consuming foods, electrolytes will also be replaced.

In summary, when it comes to meeting the nutritional requirements of ultra endurance sport competition, the paddling athlete is faced with several unique challenges. While physical training is essential, “nutritional training” must also be part of the athlete’s regimen. Experimenting with various foods and beverages is a necessary part of nutritional training. The objectives of experimentation are the following; find the right combination of foods and beverages that allow frequent consumption without significant hindrance to paddling, minimize food burnout, and obtain adequate intake of macronutrients to support optimal performance and adequate recovery. Further, when an extreme or difficult marine condition is purposely included in the training schedule, these training sessions should be viewed as opportunities to train nutritionally. Last, it is recommended that the paddling athlete attempt to develop a nutrition strategy that has the goal of meeting the current recommendations for endurance athletes. To do this, the athlete should use protein and fat calories to build upon the recommended carbohydrate amount. The multi-day race athlete may place greater emphasis on fat and protein calories than the single-day race athlete, thus achieving a greater calorie intake during competition.