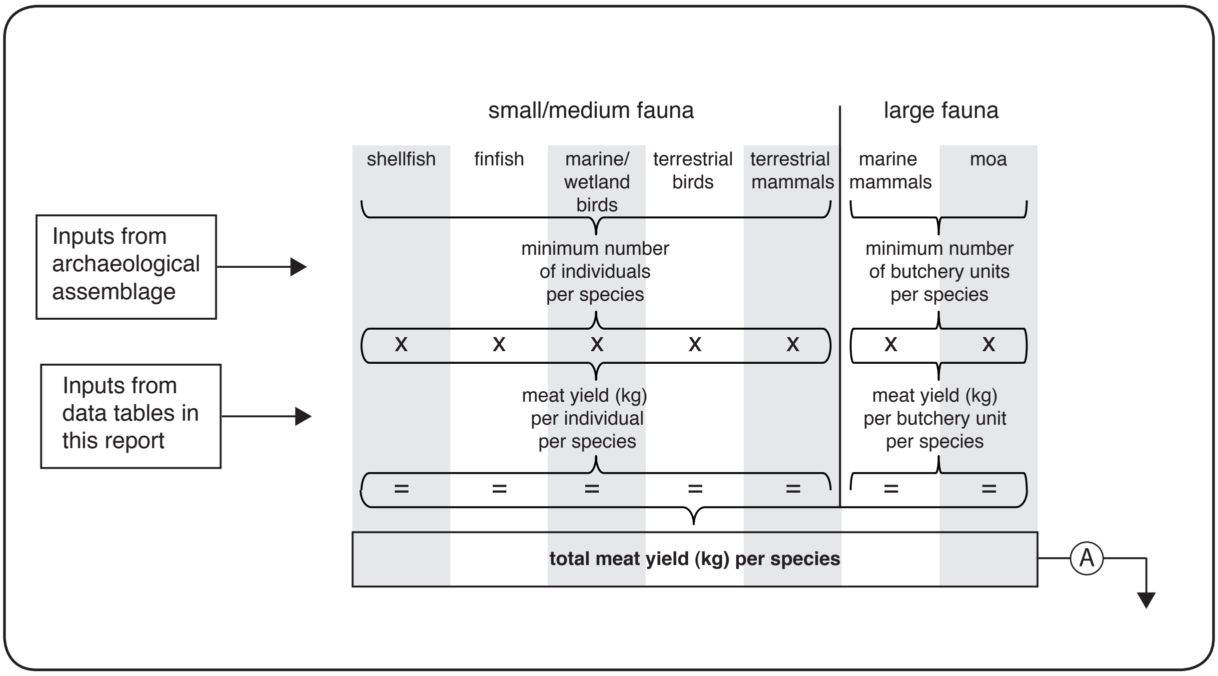
Meat Weight, Nutritional and Energy Yield Values

for

New Zealand Archaeofauna



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Introduction

This report outlines a method that can be used in evaluating the relative dietary importance of various classes of animals represented in archaeological deposits from the pre-European period in New Zealand. It also presents a standardised set of data inputs for use in such analyses in order to ensure comparability of data.

The method is based on the approach first proposed in the early 1950s by White (1953), who calculated the meat yields from exploited species by multiplying the minimum numbers of individuals for each taxon by an average weight of usable meat. Clark (1954) added a further step by converting the the weights of meat calculated for each taxon to energy yields, and Denniston (1972) also determined how much protein, carbohydrate and fat the meat represented. This basic procedure has been refined significantly through improved procedures for determining the parts of animals that were actually consumed and the weights of meat that they represent, along with more precise information on nutrient and energy yields for relevant taxa (e.g. Grayson 1979; Lyman 1979; Smith 1975; Stewart & Stahl 1977).

In New Zealand nutritional aspects of prehistoric diet in were first investigated by Shawcross (1967, 1970, 1972) using midden components excavated at Galatea Bay and Houhora in the northern North Island. His principal interest was in using the caloric value of foods represented in the middens to estimate the numbers of people and lengths of time involved in the creation of these sites, and only tangentially did he address issues of the relative importance of different foods in the diet. However he did develop the basic framework for such assessments through conducting his analyses in terms of the amounts food represented by the archaeological remains. This stimulated considerable research into more accurate methods for determining the weights of meat represented by the archaeological remains of various classes of New Zealand fauna (e.g. Nichol 1978, 1988; Smith 1985, 2004; Leach et al. 1996, 2001).

Two principal approaches have been developed for estimation of meat yields from archaeofauna. The most precise involves calculation directly from the dimensions of bones, teeth or shells recovered from archaeological deposits, using dimension-to-weight relationships derived from detailed analysis of large samples of modern specimens of the species concerned (Reitz & Wing 2008: 233-242). Algorithms for doing this are available for several New Zealand fish and shellfish species (e.g. Leach & Davidson 2001; Leach et al. 1997, 2001; Leach 2006), but the measurements necessary to apply them have been taken from only a small number of archaeological assemblages, limiting the extent to which they can be used in comparative studies. Until such data are more widely available across the taxonomic and archaeological spectra there is no option but to use a somewhat less precise approach, which is a refined version of that initially proposed by White. This has been described in detail by Smith (1985, 2004) and is outlined below, with various data inputs updated in the light of more recent research.

Method

In simple terms, the method involves multiplying the appropriate measure of abundance for each archaeofaunal taxon in an archaeological assemblage by a standardised weight of usable meat available from that taxon to calculate the total weight of meat that it yielded. These meat yield values can then be multiplied by taxa-specific values for the weights of protein, fat, and carbohydrate, and kcal of energy available per kg to calculate the total yields of each of these per taxon (Figure 1). Each of the sets of output values (A to E) can then be summed and converted to percentages to provide five measures of the relative contributions to diet from each taxonomic class in the assemblage concerned. Comparisons can then be made with other assemblages examined using the same protocols.

Each of the steps in the procedure is discussed in more detail below, before input data used in the analysis are described and presented.

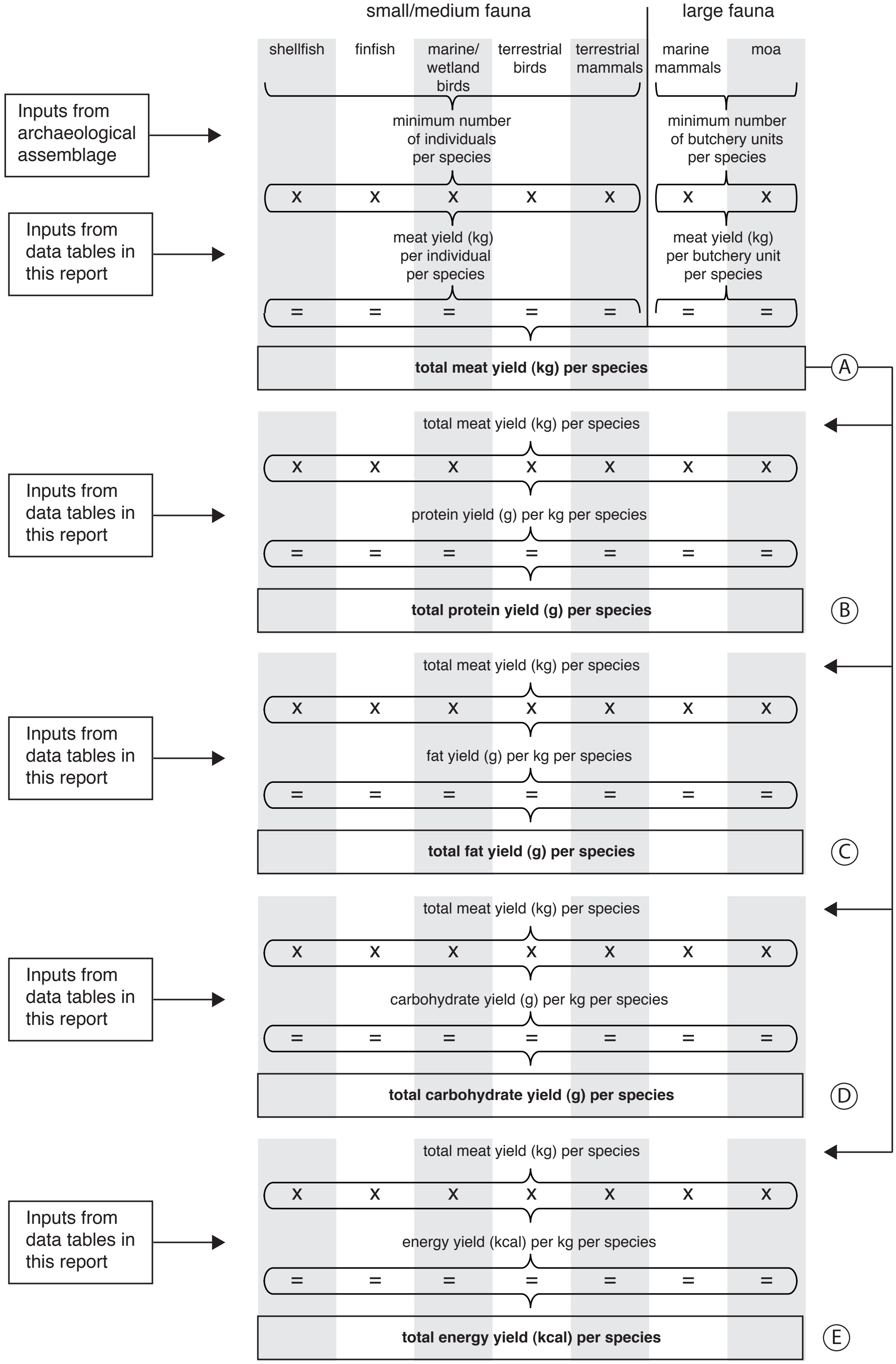

Figure 1 Schematic representation of data inputs and analytical steps in calculation of meat, nutritional and energy yields

Analytical units

Data sets for analysis should be archaeological assemblages that comprise all the faunal remains from a discrete period of activity at an archaeological site. Minimum numbers, which are the quantification units used here, are susceptible to aggregation effects which can distort both absolute and relative values, frequently exaggerating the relative importance of rarer taxa when the archaeofauna are aggregated into smaller units (Grayson 1984: 57-71; Lyman 2008). For this reason archaeofaunal data should be aggregated into the largest assemblage that is meaningful for the research questions at hand before beginning the calculation of minimum numbers. In particular, summing of minimum numbers calculated independently for smaller aggregation units should be avoided, as this is likely to amplify exaggeration effects. Where comparative studies are to be undertaken, care should be taken to ensure that the assemblages under analysis have been aggregated using similar protocols.

Taxonomic Identifications

Archaeofaunal remains are typically identified by comparison with reference specimens of known species. While many bones, teeth and shells can be identified with confidence to species level, there are frequently some for which this is not possible due to close morphological similarities between taxa or the fragmentary nature of the archaeological remains. For this reason archaeofaunal assemblages will often include specimens identified only to generic or family level, and/or to various other taxonomic categories such as 'penguin ?sp', 'seal or dog', 'fish ?sp'. Some of these items are likely to be subsumed under positively identified taxa when minimum numbers are calculated — the question asked of every such specimen is "does it indicate that an individual animal not already represented by positively identified specimens must have been present?". However it is frequently the case that some individuals will be assigned to some of the less precise taxonomic categories, making it necessary to define appropriate meat weight, nutritional and energy yield values for these.

While the calculation of meat weight, nutritional and energy yields is undertaken using the species and/or other taxonomic identifications relevant to the archaeological assemblage concerned, they are described here in seven broad categories, each of which shares the same basic analytical procedures and some key data inputs.

Measures of Taxonomic Abundance

For most classes of fauna the measure of abundance used here is the minimum number of individuals (MNI): the smallest number of individual animals necessary to account for all the remains of a taxon in an archaeological assemblage (Reitz & Wing 2008: 205-210). The presumption that underlies this is that animals in these classes were essentially complete when they arrived at an archaeological site, so that all usable meat would be available for consumption. There is nothing in New Zealand's archaeological record to suggest that this is inappropriate for shellfish, fish or small-to-medium sized birds. It is less certain that this holds for dogs (see, for example, Smith 1981), the largest species included here among the small-to-medium fauna, but as they are so seldom abundant in archaeological assemblages it is unlikely that treating them in this way will be problematic.

Seals, cetaceans and moa are significantly larger than other New Zealand archaeofauna, and there is clear evidence at numerous sites that they were sometimes represented only by partially butchered carcasses (Kooyman 1985; Smith 1985). In these circumstances, the presumption that complete animals were represented would greatly overemphasise the weight of meat derived from these taxa. For this reason abundance of large fauna is measured here by MNI only where the range of skeletal elements represented in an assemblage indicate that a complete or near complete individual was present. Where skeletal representation indicates that only selected body parts were present, abundance is measured in terms of the minimum number of butchery units (MNBU): the smallest number of butchery units necessary to account for all of the remains of a taxon in an archaeological assemblage. Butchery units, and the skeletal elements used to indicate their presence, are defined for each of the large archaeofaunal taxa in the relevant sections below.

For the large fauna, size differences relating to age and sex can also have a significant influence on available meat weight. Evidence of age and sex can sometimes be derived from seal remains (Smith 1985: 55-78), and where it is available MNI/MNBU are calculated for each age/sex class.

Meat Yields per Taxon

The approach used here relies upon a mean weight of usable meat (MTWT) for each species or other taxonomic group. Exactly which parts of an animals carcass are 'usable' as meat depends upon a range of factors, both physical and cultural (Reitz and Wing 2008: 233-242). There is little problem with excluding bone and hide, but there is considerable cultural variation in which components of viscera would be excluded from consumption. The values adopted for each class of animals here are conservative estimates of what is likely to have been usable meat in the New Zealand setting. Details of these values and the rationale for their selection are given in the relevant sections below.

Nutritional and Energy Yields per Taxon

Yields of protein, fat, carbohydrate and caloric energy per kg of meat for each category of animal were derived from a range of sources. Data from detailed proximate composition analysis was available for most of the finfish under analysis here, and for a small number of the shellfish. For all other taxa it was necessary to adopt values from comparable species or derive them from the best available sources. Details of the data sources used are set out in the relevant section below.

Data Inputs

Marine Mammals

Taxonomic terminology for marine mammals follows Baker et al. (2010). Four species of seals have been identified from New Zealand archaeological sites: the New Zealand fur seal (*Arctocephalus forsteri*), New Zealand sea lion (*Phocarctus hookeri*), Southern elephant seal (*Mirounga leonina*) and Leopard seal (*Hydrurga leptonyx*). For the first three of these it is sometimes possible to place the archaeological remains into one of five age/sex catgories, which exhibit significant differences in body size (Smith 1985: 43-55), and these are treated here as discrete taxonomic categories for analysis of meat, nutritional and energy yields. Some archaeological remains can be identified only as belonging to one of the smaller (fur seal/sea lion) or larger (elephant seal/ leopard) species, or simply as 'seal ?sp', and if these are not subsumed within a positively identified species during calculation of minimum numbers, are treated as separate taxonomic groups. Body weight (BWT) estimates for each group (Table 1) are drawn from Smith (1985: 120-127).

Detailed studies of body size and composition in marine mammals indicate that usable meat varies from 56% to 63% of BWT, depending upon species, age and sex (Bryden 1969, 1972; Omura 1950). There were used in conjunction with data on the distribution of muscle mass to derive a suite of values for complete carcass and butchery unit MTWT for each species and age/sex class of seals in the New Zealand archaeological record (Smith 1985: 120-127). Skeletal elements used in identifying butchery units in seals are are shown in Table 2. An arbitrary value of 10% MTWT was assumed for butchering units in cetaceans.

In marine mammals there are considerable differences in the nutritional and energy yields from flesh and blubber. The values used here for seals are based on Smith's (1985: 131) MEANMT calculations which assume that only half of the blubber available with any partial or complete carcass contributed to the diet, and combine the protein, fat and carbohydrate values for seal flesh (Sinclair 1953: 74) and blubber (Denniston 1972: 185) accordingly, and calculate energy yield assuming that fat would produce 9 kcal/g and both protein and carbohydrate 4 kcal/g (Robinson 1975: 45, 53, 57).

Table 1 **Marine Mammals: body weight (BWT), meat weight (MTWT), nutritional and energy yields**

Taxon	Age/sex [1]	BWT (kg)	MTWT (kg) complete carcass	head	upper forelimb	upper hindlimb	trunk	arbitrary BU[2]	Protein (g/kg)	Fat (g/kg)	Carbohydrate (g/kg)	Energy (kcal/kg)
furseal	pup	8.60	4.82	0.72	0.72	0.48	1.68	-	140	220	20	2620
	juvenile	25.00	14.38	2.16	2.16	1.44	5.03	-	140	220	20	2620
	subadult male	100.00	59.00	8.85	8.85	5.90	20.65	-	140	220	20	2620
	adult female	50.00	30.00	4.50	4.50	3.00	10.50	-	140	220	20	2620
	adult male	150.00	94.50	14.18	14.18	9.45	33.07	-	140	220	20	2620
	unknown[3]	75.00	44.25	6.64	6.64	4.43	15.49	-	140	220	20	2620
sealion	pup	12.90	7.22	1.08	1.08	0.72	2.53	-	140	220	20	2620
	juvenile	37.50	17.25	2.59	2.59	1.73	6.04	-	140	220	20	2620
	subadult male	150.00	88.50	13.28	13.28	8.85	30.98	-	140	220	20	2620
	adult female	75.00	49.50	7.43	7.43	4.95	17.33	-	140	220	20	2620
	adult male	225.00	141.75	21.26	21.26	14.18	49.61	-	140	220	20	2620
	unknown[3]	112.50	66.38	9.96	9.96	6.64	23.23	-	140	220	20	2620
elephant seal	pup	140.00	74.55	10.44	8.20	2.98	41.75	-	130	240	20	2760
	juvenile	200.00	106.50	14.91	11.72	4.26	59.64	-	130	240	20	2760
	subadult male	500.00	276.25	38.68	30.38	11.05	154.70	-	130	240	20	2760
	adult female	300.00	168.00	23.52	18.48	6.72	94.08	-	130	240	20	2760
	adult male	2000.00	1205.00	168.70	132.52	48.20	674.80	-	130	240	20	2760
	unknown[3]	1000.00	550.00	77.00	60.50	22.00	308.00	55.00	130	240	20	2760
leopard seal	adult male	250.00	150.00	21.00	16.50	6.00	84.00	-	130	240	20	2760
	unknown[3]	125.00	68.75	9.63	7.56	2.75	38.50	6.88	130	240	20	2760
fur seal/sea lion[4]	-	-	55.32	8.30	8.30	5.54	19.36	5.53	140	220	20	2620
elephant seal/leopard seal[5]	-	-	309.38	43.32	34.03	12.38	173.25	30.94	130	240	20	2760
seal ?sp[6]	-	-	182.35	25.81	21.17	8.96	96.31	18.24	135	230	20	2690
pilot whale ?sp	-	1360.00	829.60	-	-	-	-	82.96	160	140	10	1940
dolphin ?sp	-	84.50	51.60	-	-	-	-	5.16	160	140	10	1940
cetacean ?sp[7]	-	-	-	-	-	-	-	44.60	160	140	10	1940
large marine mammal ?sp[8]	-	-	-	-	-	-	-	37.50	145	190	15	2350

Notes: 1 – age/sex categories defined by Smith 1985: 43-55; 2 – arbitrary butchery unit set at 10% of complete carcass MTWT; 3 – animals of 'unknown' age/sex calculated at 50% of adult male values; 4 – based on mean of fur seal and sealion 'unknown' values; 5 – based on mean of elephant seal and leopard seal 'unknown' values; 6 – based on mean of all seal 'unknown' values 7 – based on mean of pilot whale and dolphin values; 8 – based on mean of elephant seal/leopard seal and cetacean ?sp values

Table 2 Butchery units in seals (after Smith 1985: 464-473)

Butchery unit	Skeletal elements
head	cranium; teeth; mandible; hyoid; cervical vertebrae
trunk	thoracic, lumbar, sacral and caudal vertebrae; ribs; sternum; pelvis
upper forelimb	scapula; humerus; radius; ulna
lower forelimb	carpals; metacarpals; phalanges
upper hindlimb	tarsals; metatarsals; phalanges

Although 56 species of whale are known from New Zealand waters (Baker et al. 2010), very few have been identified from archaeological contexts, generally because the relatively small numbers of skeletal elements recovered lack sufficient distinctive morphological characteristics. Those that have been identified include Pilot whales (*Globicephala* sp.) and the Common dolphin (*Delphinus delphis*) and Hector's dolphin (*Cephalorhyncus hectori*), with most others identified simply as dolphin ?sp or cetacean ?sp.. The body weight estimates for these groups (Table 1) are taken from Smith (1985: 127-129). Where there has been detailed examination of cetacean remains in archaeological contexts, it has usually been concluded that it is unlikely that complete carcasses were used as food (Smith 1985). To accommodate this an arbitrary butchery unit of 10% of total carcass MTWT has been adopted. The nutrient and energy yield values listed for cetaceans were calculated from the nutritive values for whale flesh and blubber (Denniston 1972), using the same protocols described above for seals.

Terrestrial Mammals

Taxonomic terminology for terrestrial mammals follows King (1995). Only two species, both commensals, are represented in New Zealand during the pre-European period (Table 3). For the Polynesian dog (*Canis familiaris*) age can sometimes be determined from epiphyseal fusion and bone dimensions (Allo 1970; Clark 1997), and body weight (BWT) values were estimated for three age classes (juvenile, subadult, adult) by Smith (1985: 485-486). The subadult values are utilised for animals of unknown age. Usable meat weight (MTWT) is calculated at 60% of BWT, being a conservative estimate between the 50% suggested by White (1953) for wolves and foxes and the 80% sometimes reached in Siberian huskies (Stewart & Stahl 1977).

For the Polynesian rat (*Rattus exulans*) the BWT estimate is from Smith (1985: 487), and usable meat weight estimated at 70%, following White (1953: Table 14) and Smith (1985: 485-487).

No precise nutritional and energy yield data are available for either species, and the figures shown in Table 3 are those for 'venison' (Altman & Dittmar 1968: 14).

Table 3 Terrestrial Mammals: body weight, meat weight nutritional and energy yields

Taxon	Age	BWT (kg)	MTWT (kg)	Protein (g/kg)	Fat (g/kg)	Carbohydrate (g/kg)	Energy (kcal/kg)
dog	juvenile	5.0	3.0	210	40	0	1260
	subadult	10.0	6.0	210	40	0	1260
	adult	12.5	10.0	210	40	0	1260
	unknown	10.0	6.0	210	40	0	1260
rat	-	0.14	0.10	210	40	0	1260

Moa

Moa taxonomy follows Checklist Committee (2010), with categories added for individuals or butchery units identifiable only to higher taxonomic levels, or as moa ?sp using separate values for North Island and South Island examples of the latter because of the differing size range of moa species present on each island (Table 4). Recent genetic and morphometric research has shown that there was considerable sexual dimorphism and regional size variations in some species (Bunce et al. 2003; Huyen et al. 2003; Worthy et al. 2005), making the use of average body weights less than ideal. However there is little option at present, as size reconstruction is seldom possible from fragmentary archaeological remains. Body weights (BWT) are based on the body mass values calculated from femur lengths for Holocene specimens reported by Worthy & Holdaway (2001: Tables 5.3 and 5.6), except for the subsequently revised *Dinornis* species. For the latter, which show the greatest degree of regional variation, means of reconstructed weights for both sexes from low altitude/low rainfall regions (Worthy et al. 2005: Appendix 1 - for North Island, Takapau Road; for South Island , Canterbury) have been employed, as the majority of archaeological sites are in similar environments. Meat weights (MTWT) are calculated at 60% of BWT. Where moa are represented by only the femur and/or tibiotarsus, a meat yield for the major butchery unit, the leg (LEGWT) is used, with the values calculated at 14.5% of BWT, based on leg muscle mass in ostriches (Alexander et al. 1979: 175; Smith 1985: 474-478).

With no nutritional or energy yield data available from any of the living ratites, it was necessary to select an appropriate analogue for moas. It has been suggested that their flesh would have had a high fat content and consequently a high energy yield (Shawcross 1972: 612), but the information available for flightless birds indicate only moderate levels for these components (Altman & Dittmar 1968: 10-14). The figures employed here are those for 'turkey', which has the highest fat content of all flightless birds examined.

Table 4 Moas: body weight (BWT), meat weight (MTWT), nutritional and energy yields

Taxon		region[1]	BWT (kg)	MTWT (kg)	LEGWT (kg)	protein (g/kg)	fat (g/kg)	carbo. (g/kg)	energy (kcal/kg)
Little bush moa	*Anomalopteryx didiformis*	NI, SI	40.0	24.0	8.0	300	80	0	2030
Upland moa	*Megalapteryx didinus*	SI	40.0	24.0	8.0	300	80	0	2030
Mantell's moa	*Pachyornis geranoides*	NI	27.0	16.2	5.4	300	80	0	2030
Heavy-footed moa	*Pachyornis elephantopus*	SI	80.0	48.0	16.0	300	80	0	2030
Created moa	*Pachyornis australis*	SI	67.0	40.2	13.4	300	80	0	2030
Pachyornis ?sp[2]		SI	73.5	44.1	14.7	300	80	0	2030
Eastern moa	*Emeus crassus*	SI	58.0	34.8	11.6	300	80	0	2030
Coastal moa	*Euryapteryx curtus*	NI	20.0	12.0	4.0	300	80	0	2030
Sout-legged moa	*Euryapteryx gravis*	NI, SI	75.0	45.0	15.0	300	80	0	2030
Eurypateryx ?sp[3]		NI	47.5	28.5	9.5	300	80	0	2030
Emeus/Eurypateryx ?sp[4]		SI	51.0	30.6	10.2	300	80	0	2030
North Island Giant moa	*Dinornis novaezealandiae*	NI	100.0	60.0	20.0	300	80	0	2030
South Island Giant moa	*Dinornis giganteus*	SI	125.0	75.0	25.0	300	80	0	2030
moa ?sp[5]		NI	90.0	54.0	18.0	300	80	0	2030
moa ?sp[6]		SI	103.3	62.0	20.7	300	80	0	2030

Notes: 1 – NI = North Island, SI = South Island; 2 – mean of *P. elephantopus* and *P. australis*; 3 - mean of *Eu. curtus* and *Eu. geranoides* 4 – mean of *Em. crassus* and *Eu. geranoides*; 5 – mean of all NI species; 6 – mean of all SI species

Small-to-Medium Birds – Terrestrial; Marine and Wetland

The taxonomic nomenclature used here for small-to-medium sized birds follows Checklist Committee (2010), with the addition of categories to accommodate individuals not identifiable to species level. Body weights (BWT) are taken from the body mass values given by Holdaway (1999) and Smith (1985), with mean values for relevant groups of species used as estimates for the additional taxon groups (Table 5).

Table 5 Small-to-Medium Birds: body weight (BWT), meat weight (MTWT), nutritional and energy yields

Taxon		Habitat	Body Wt kg	MTWT kg	Protein g/kg	Fat g/kg	Carb. g/kg	Energy kcal/kg
Northern brown kiwi	*Apteryx mantelli*	T	1.500[3]	1.050	280	60	0	1760
Southern brown kiwi	*Apteryx australis*	T	1.500[1]	1.050	280	60	0	1760
Little spotted kiwi	*Apteryx owenii*	T	1.200[1]	0.840	280	60	0	1760
Great spotted kiwi	*Apteryx haastii*	T	2.200[1]	1.540	280	60	0	1760
NZ quail	*Coturnix novaezelandiae*	T	0.100[1]	0.070	280	60	0	1760
Black swan	*Cygnus atratus*	W	5.000[1]	3.500	160	290	0	3210
North Island goose	*Cnemiornis gracilis*	T	8.000[1]	5.600	280	60	0	1760
South Island goose	*Cnemiornis calcitrans*	T	10.000[1]	7.000	280	60	0	1760
Scarlett's Duck	*Malacorhynchus scarletti*	W	0.800[1]	0.560	160	290	0	3210
NZ musk duck	*Biziura delautouri*	W	2.000[1]	1.400	160	290	0	3210
Paradise shelduck	*Tadorna variegata*	W	1.400[1]	0.980	160	290	0	3210
NZ merganser	*Mergus australis*	W	0.900[1]	0.630	160	290	0	3210
Finch's duck	*Chenonetta finschi*	W	0.800[1]	0.560	160	290	0	3210
Blue Duck	*Hymenolaimus malacorhyncus*	W	0.750[1]	0.525	160	290	0	3210
Grey teal	*Anas gracilis*	W	0.425[1]	0.298	160	290	0	3210
Brown teal	*Anas chlorotis*	W	0.500[1]	0.350	160	290	0	3210
Grey duck	*Anas superciliosa*	W	1.000[1]	0.700	160	290	0	3210
Australasian shoveler	*Anas rhynchotis*	W	0.600[2]	0.420	160	290	0	3210
duck Anas ?sp	*Anas* ?sp	W	0.631[4]	0.442	160	290	0	3210
NZ scaup	*Aythya novaeseelandiae*	W	0.650[1]	0.455	160	290	0	3210
Australasian crested grebe	*Podiceps cristatus australis*	W	1.100[1]	0.770	160	290	0	3210
NZ dabchick	*Poliocephalus rufopectus*	W	0.250[1]	0.175	160	290	0	3210
NZ crested penguin	*Eudyptes pachyrhynchus*	M	4.000[1]	2.800	160	290	0	3210
penguin Eudyptes ?sp	*Eudyptes* ?sp	M	4.000[3]	2.800	160	290	0	3210
Yellow-eyed penguin	*Megadyptes antipodes*	M	5.250[1]	3.675	160	290	0	3210
Waitaha penguin	*Megadyptes waitaha*	M	5.250[3]	3.675	160	290	0	3210
Little penguin	*Eudyptula minor*	M	1.100[1]	0.770	160	290	0	3210
penguin ?sp	*Spheniscidae* ?sp	M	3.450[4]	2.415	160	290	0	3210
Wandering albatross	*Diomedea exulans*	M	8.000[2]	5.600	160	290	0	3210
Southern royal albatross	*Diomedea epomorphora*	M	8.000[2]	5.600	160	290	0	3210
Grey-headed albatross	*Thalassarche chrysostoma*	M	4.500[2]	3.150	160	290	0	3210
Black-browed albatross	*Thalassarche melanophris*	M	4.500[2]	3.150	160	290	0	3210
Buller's albatross	*Thalassarche bulleri*	M	4.500[2]	3.150	160	290	0	3210
White-capped albatross	*Thalassarche cauta*	M	4.500[2]	3.150	160	290	0	3210
Chatham Island albatross	*Thalassarche eremita*	M	4.500[2]	3.150	160	290	0	3210
Salvin's albatross	*Thalassarche salvini*	M	4.500[2]	3.150	160	290	0	3210
Light-mantled sooty albatross	*Phoebetria palpabrata*	M	4.500[2]	3.150	160	290	0	3210
Albatross ?sp	Diomedidae ?sp	M	4.500[2]	3.150	160	290	0	3210
Southern giant petrel	*Macronectes giganteus*	M	4.500[2]	3.150	160	290	0	3210
Northern giant petrel	*Macronectes halli*	M	4.500[3]	3.150	160	290	0	3210
Cape petrel	*Daption capense*	M	0.500[2]	0.350	160	290	0	3210
Grey-faced petrel	*Pterodroma macroptera gouldi*	M	0.500[1]	0.350	160	290	0	3210
White-headed petrel	*Pterodroma lessonii*	M	0.500[2]	0.350	160	290	0	3210
Chatham taiko	*Pterodroma magentae*	M	0.500[2]	0.350	160	290	0	3210
Mottled petrel	*Pterodroma inexpectata*	M	0.325[1]	0.228	160	290	0	3210
Black-winged petrel	*Pterodroma nigripennis*	M	0.180[2]	0.126	160	290	0	3210

Table 5 continued

Taxon		Habitat	Body Wt kg	MTWT kg	Protein g/kg	Fat g/kg	Carb. g/kg	Energy kcal/kg
Cook's petrel	*Pterodroma cookii*	M	0.200[1]	0.140	160	290	0	3210
Pycroft's petrel	*Pterodroma pycrofti*	M	0.160[1]	0.112	160	290	0	3210
petrel - Pterodroma ?sp	*Pterodroma* ?sp	M	0.342[4]	0.239	160	290	0	3210
Blue petrel	*Halobaena caerulea*	M/W	0.200[2]	0.140	160	290	0	3210
Broad-billed prion	*Pachyptila vitata*	M	0.200[2]	0.140	160	290	0	3210
Fairy prion	*Pachyptila turtur*	M	0.125[1]	0.088	160	290	0	3210
Fulmar prion	*Pachyptila crassirostris*	M	0.150[2]	0.105	160	290	0	3210
prion - Pachyptila ?sp	*Pachyptila* ?sp	M	0.158[4]	0.111	160	290	0	3210
White-chinned petrel	*Procellaria aequinoctialis*	M	1.100[3]	0.770	160	290	0	3210
Westland petrel	*Procellaria westlandica*	M	1.100[1]	0.770	160	290	0	3210
Parkinson's petrel	*Procellaria parkinsoni*	M	0.700[1]	0.490	160	290	0	3210
Grey petrel	*Procellaria cinerea*	M	1.100[3]	0.770	160	290	0	3210
Buller's shearwater	*Puffinus bulleri*	M	0.900[2]	0.630	160	290	0	3210
Flesh-footed shearwater	*Puffinus carneipes*	M	0.900[2]	0.630	160	290	0	3210
Sooty shearwater	*Puffinus griseus*	M	0.800[1]	0.560	160	290	0	3210
Short-tailed shearwater	*Puffinus tenuirostris*	M	0.600[2]	0.420	160	290	0	3210
Fluttering shearwater	*Puffinus gavia*	M	0.300[1]	0.210	160	290	0	3210
Scarlett's shearwater	*Puffinus spelaeus*	M	0.250[1]	0.175	160	290	0	3210
Hutton's shearwater	*Puffinus huttoni*	M	0.350[1]	0.245	160	290	0	3210
Norfolk little shearwater	*Puffinus assimilis*	M	0.200[1]	0.140	160	290	0	3210
Shearwater - Puffinus ?sp	*Puffinus* ?sp	M	0.538[4]	0.376	160	290	0	3210
Grey-back storm petrel	*Garrodia nereis*	M	0.035[1]	0.025	160	290	0	3210
White-faced storm petrel	*Pelagodroma marina*	M	0.045[1]	0.032	160	290	0	3210
NZ storm petrel	*Pealeornis maorianus*	M	0.050[3]	0.035	160	290	0	3210
Common diving petrel	*Pelecanoides urinatrix*	M	0.130[1]	0.091	160	290	0	3210
South Georgian diving petrel	*Pelecanoides georgicus*	M	0.120[1]	0.084	160	290	0	3210
Petrel ?sp	Procellariidae ?sp	M	0.325[4]	0.228	160	290	0	3210
Australian pelican	*Pelecanus conspicillatus*	M	2.000[2]	1.400	160	290	0	3210
Australasian gannet	*Morus serrator*	M	2.300[1]	1.610	160	290	0	3210
Little shag	*Phalacrocorax melanoleucos*	M	0.700[1]	0.490	160	290	0	3210
Black shag	*Phalacrocorax carbo*	M	2.200[1]	1.540	160	290	0	3210
Pied shag	*Phalacrocorax varius*	M	2.000[1]	1.400	160	290	0	3210
Little black shag	*Phalacrocorax sulcirostris*	M	0.900[2]	0.630	160	290	0	3210
Shag - Phalacrocorax ?sp	Phalacrocorax ?sp	M	1.633[4]	1.143	160	290	0	3210
N.Z. King shag	*Leucocarbo carunculatus*	M	2.500[1]	1.750	160	290	0	3210
Stewart Island shag	*Leucocarbo chalconotus*	M	2.500[1]	1.750	160	290	0	3210
Spotted shag	*Stictocarbo punctatus*	M	1.200[1]	0.840	160	290	0	3210
shag ?sp	*Phalacrocoridae* ?sp	M	1.583[4]	1.108	160	290	0	3210
White heron	*Ardea modesta*	W	0.900[1]	0.630	160	290	0	3210
White-faced heron	*Egretta novaehollandiae*	W	0.550[3]	0.385	160	290	0	3210
Reef heron	*Egretta sacra*	W	0.400[1]	0.280	160	290	0	3210
Australasian bittern	*Botaurus poiciloptilus*	W	1.000[1]	0.700	160	290	0	3210
NZ little bittern	*Ixobrychus novaezelandiae*	W	0.150[1]	0.105	160	290	0	3210
Australasian harrier	*Circus approximans*	T	0.500[2]	0.350	280	60	0	1760
Eyles's harrier	*Circus teauteensis*	T	2.500[1]	1.750	280	60	0	1760
Haast's eagle	*Aquila moorei*	T	12.000[1]	8.400	280	60	0	1760
NZ falcon	*Falco novaeseelandiae*	T	0.500[1]	0.350	280	60	0	1760

Table 5 continued

Taxon		Habitat	Body Wt kg	MTWT kg	Protein g/kg	Fat g/kg	Carb. g/kg	Energy kcal/kg
North island adzebill	*Aptornis otidiformis*	T	8.000[1]	5.600	280	60	0	1760
South Island adzebill	*Aptornis defossor*	T	10.000[1]	7.000	280	60	0	1760
Banded rail	*Gallirallus philippensis*	T	0.170[1]	0.119	280	60	0	1760
Weka	*Gallirallus australis*	T	0.700[1]	0.490	280	60	0	1760
Snipe rail	*Capellirallus karamu*	T	0.275[1]	0.193	280	60	0	1760
Spotless crake	*Porzana tabuensis*	W	0.045[1]	0.032	160	290	0	3210
Marsh crake	*Porzana pusilla*	W	0.040[1]	0.028	160	290	0	3210
Hodgen's waterhen	*Gallinula hodgenorum*	W	0.450[1]	0.315	160	290	0	3210
Pukeko	*Porphyrio melanotus*	W	1.000[2]	0.700	160	290	0	3210
North Island takehe	*Porphyrio mantelli*	W	3.500[1]	2.450	160	290	0	3210
South Island takehe	*Porphyrio hochstetteri*	W	3.000[1]	2.100	160	290	0	3210
NZ coot	*Fulica prisca*	W	1.000[1]	0.700	160	290	0	3210
North Island snipe	*Coenocorypha barrierensis*	T	0.105[1]	0.074	280	60	0	1760
South Island snipe	*Coenocorypha iredalei*	T	0.105[1]	0.074	280	60	0	1760
Lesser knot	*Calidras canutus rogersi*	M	0.080[2]	0.056	160	290	0	3210
Whimbrel	*Numenius phaeopus*	M	0.400[2]	0.280	160	290	0	3210
Bar-tailed godwit	*Limosa lapponica*	M	0.400[2]	0.280	160	290	0	3210
Variable oystercatcher	*Haematopus unicolor*	W	0.725[1]	0.508	160	290	0	3210
South Is. pied oystercatcher	*Haematopus finschi*	W	0.550[1]	0.385	160	290	0	3210
Pied stilt	*Himantopus himantopus*	W	0.220[3]	0.154	160	290	0	3210
Black stilt	*Himantopus novaezelandiae*	W	0.220[1]	0.154	160	290	0	3210
NZ dotterel	*Charadrius obscurus*	M	0.145[1]	0.102	160	290	0	3210
Banded dotterel	*Charadrius bicinctus*	W	0.060[1]	0.042	160	290	0	3210
dotterel ?sp	*Charadrius* ?sp	W	0.103[4]	0.072	160	290	0	3210
Wrybill	*Anarhynchus frontalis*	M	0.055[1]	0.039	160	290	0	3210
Shore plover	*Charadrius antarctica*	M	0.060[1]	0.042	160	290	0	3210
Southern skua	*Catharacta antarctica*	M	1.950[1]	1.365	160	290	0	3210
Arctic skua	*Stercoraria parasiticus*	M	1.400[2]	0.980	160	290	0	3210
Southern black-backed gull	*Larus dominicanus*	M	0.850[1]	0.595	160	290	0	3210
Red-billed gull	*Larus novaehollandiae*	M	0.260[1]	0.182	160	290	0	3210
Black-billed gull	*Larus bulleri*	M	0.250[1]	0.175	160	290	0	3210
gull ?sp	Larinae ?sp	M	0.453[4]	0.317	160	290	0	3210
Fairy tern	*Sternula nereis*	M	0.070[1]	0.049	160	290	0	3210
Caspian tern	*Hydroprogne caspia*	M	0.700[1]	0.490	160	290	0	3210
Black-fronted tern	*Childonias albostriata*	M	0.080[1]	0.056	160	290	0	3210
White-fronted tern	*Sterna striata*	M	0.160[1]	0.112	160	290	0	3210
tern ?sp	Sterninae ?sp	M	0.253[4]	0.177	160	290	0	3210
wader ?sp	Charadriiforme ?sp	M/W	0.289[4]	0.202	160	290	0	3210
NZ pigeon	*Hemiphaga novaeseelandiae*	T	0.650[1]	0.455	280	60	0	1760
Kakapo	*Strigops habroptilis*	T	2.000[1]	1.400	280	60	0	1760
Kaka	*Nestor meridionalis*	T	0.425[1]	0.298	280	60	0	1760
Kea	*Nestor notabilis*	T	0.800[1]	0.560	280	60	0	1760
Red-crowned parakeet	*Cyanoramphus novaezelandiae*	T	0.070[1]	0.049	280	60	0	1760
Yellow-crowned parakeet	*Cyanoramphus auriceps*	T	0.040[1]	0.028	280	60	0	1760
Orange-fronted parakeet	*Cyanoramphus malherbi*	T	0.035[1]	0.025	280	60	0	1760
parakeet ?sp	*Cyanoramphus* ?sp	T	0.048[4]	0.034	280	60	0	1760

Table 5 continued

Taxon		Habitat	Body Wt kg	MTWT kg	Protein g/kg	Fat g/kg	Carb. g/kg	Energy kcal/kg
Shining cuckoo	*Chrysococcyx lucidus*	T	0.025[1]	0.018	280	60	0	1760
Long-tailed cuckoo	*Eudynamys taitensis*	T	0.125[1]	0.088	280	60	0	1760
Morepork	*Ninox novaeseelandiae*	T	0.175[1]	0.123	280	60	0	1760
Laughing owl	*Sceloglaux albifaces*	T	0.600[1]	0.420	280	60	0	1760
NZ owlet-nightjar	*Aegotheles novaezelandiae*	T	0.200[1]	0.140	280	60	0	1760
NZ kingfisher	*Todiramphus sancta vagans*	T	0.065[1]	0.046	280	60	0	1760
Rifleman	*Acanthisitta chloris*	T	0.007[1]	0.005	280	60	0	1760
Bush wren	*Xencius longipes*	T	0.016[1]	0.011	280	60	0	1760
Rock wren	*Xencius gilviventris*	T	0.020[1]	0.014	280	60	0	1760
Lyall's wren	*Traversia lyalli*	T	0.022[1]	0.015	280	60	0	1760
South Is. stout-legged wren	*Pachyplichas yaldwyni*	T	0.050[1]	0.035	280	60	0	1760
Long-billed wren	*Dendroscansor decurvirostris*	T	0.030[1]	0.021	280	60	0	1760
North Island kokako	*Callaeas wilsoni*	T	0.230[1]	0.161	280	60	0	1760
South Island kokako	*Callaeas cinerea*	T	0.230[1]	0.161	280	60	0	1760
North Island saddleback	*Philesturnus rufusater*	T	0.070[1]	0.049	280	60	0	1760
South Island saddleback	*Philesturnus carunculatus*	T	0.070[1]	0.049	280	60	0	1760
Huia	*Heteralocha acutirostris*	T	0.300[1]	0.210	280	60	0	1760
Stitchbird	*Notiomystis cincta*	T	0.030[1]	0.021	280	60	0	1760
North Island piopio	*Turnagra tanagra*	T	0.130[1]	0.091	280	60	0	1760
South Island piopio	*Turnagra capensis*	T	0.130[1]	0.091	280	60	0	1760
Grey warbler	*Gerygone igata*	T	0.007[1]	0.005	280	60	0	1760
NZ bellbird	*Anthornis melanura*	T	0.026[1]	0.018	280	60	0	1760
Tui	*Prosthemadra novaeseelandiae*	T	0.090[1]	0.063	280	60	0	1760
Whitehead	*Mohoua albicilla*	T	0.015[1]	0.011	280	60	0	1760
Yellowhead	*Mohoua ochrocephala*	T	0.025[1]	0.018	280	60	0	1760
Brown creeper	*Mohoua novaeseelandiae*	T	0.011[1]	0.008	280	60	0	1760
NZ fantail	*Rhipidura fuliginosa*	T	0.008[1]	0.006	280	60	0	1760
NZ raven	*Corvus antipodum*	T	0.950[1]	0.665	280	60	0	1760
Tomtit	*Petroica macrocephala*	T	0.011[1]	0.008	280	60	0	1760
North Island robin	*Petroica longipes*	T	0.035[3]	0.025	280	60	0	1760
South Island robin	*Petroica australis*	T	0.035[1]	0.025	280	60	0	1760
Fernbird	*Bowdleria punctata*	T	0.035[1]	0.025	280	60	0	1760
NZ pipit	*Anthus novaeseelandiae*	T	0.040[1]	0.028	280	60	0	1760

Habitat codes: M – marine; T – terrestrial; W – wetland.

Body weights from : 1 – Holdaway 1999: Appendix 1; 2 – Smith 1985: Tables 96, 97; 3 – based on comparable species; 4 – mean of relevant species

Usable meat weight (MTWT) was assumed to represent 70% of mean body weight per taxon, following White (1953: Table 14) and Smith (1985: 485-487). Small-to-medium sized birds are divided into two groups for the analysis of nutritional and energy yields, as the flesh of marine and wetland birds has higher fat and lower protein content than is the case for terrestrial birds. Nutritional and energy values for 'medium-fat duck' (Denniston 1972: 193) were employed for the former, while those for 'chicken' (Altman & Dittmar 1968: 10) were used for the latter. Relevant categories and values are shown in Table 5.

Finfish

Finfish taxonomy follows *FishBase* (Froese & Pauly 2010), using common names from Paul (2000). Several family or other supra-species categories are included to accomodate those taxa difficult to separate on the basis of skeletal morphology (Table 6). Body weights (BWT) are calculated from mean lengths (Paul 2000; Leach 2006) and length-to-weight formulae (Froese & Pauly 2010; Leach 2006) where available, historical data (Maxwell 2010), or are best estimates. Unsable meat weight (MTWT) is assumed to represent 70% of mean body weight per taxon, following White (1953: Table 14) and Smith (1985: 485-487).

Vlieg (1988) has undertaken detailed proximate composition analysis of most finfish species exploited commercially in New Zealand, and his 'whole fish' protein and oil values (*ibid.*: Table 3) are utilised here along with a standard value for carbohydrate (*ibid.*: 5). Energy yield was calculated from these assuming that oil would produce 9 kcal/g and both protein and carbohydrate 4 kcal/g (Robinson 1975: 45, 53, 57). For those taxa represented archaeologically but not examined by Vlieg, estimates are based on comparable species.

Table 6 Finfish: body weight (BWT), meat weight (MTWT), nutritional and energy yields

Taxon		BWT kg	MTWT kg	Protein g/kg	Fat g/kg	Carb g/kg	Energy kcal/kg
School shark	*Galeorhinus galeus*	20.00[1]	14.00	185	44	2	1144
Shark ?sp	shark ?sp	20.00[8]	14.00	185	44	2	1144[9]
Spiny dogfish	*Squalus acanthias*	2.50[2]	1.75	172	93	2	1533
Northern dogfish	*Squalus blainvillei*	2.50[2]	1.75	172	93	2	1533[10]
Eagle Ray	*Myliobatis tenuicaudatus*	20.00[8]	14.00	172	93	2	1533[10]
Elasmobranch ?sp	elasmobranch ?sp	10.00[8]	7.00	179	69	2	1339[11]
eel spp.	*Anguilla* ?sp	0.90[7]	0.63	166	45	2	1077[12]
Conger eel	*Conger verreauxi*	1.90[2]	1.33	166	45	2	1077[12]
Red cod	*Pseudophycis bachus*	1.50[3]	1.05	160	18	2	810
Rock cod	*Lotella rhacina*	1.00[8]	0.70	160	18	2	810[13]
Morid cods	Moridae ?sp	1.25[7]	0.88	160	18	2	810[13]
Ling	*Genypterus blacodes*	5.00[2]	3.50	185	15	2	883
John dory	*Zeus faber*	1.40[2]	0.98	181	32	2	1020
Sea perch	*Helicolenus barathri*	0.40[2]	0.28	138	15	2	695
Red rock cod	*Scorpaena papillosus*	1.00[2]	0.70	138	15	2	695[14]
Red scorpionfish	*Scorpaena cardinalis*	0.20[2]	0.14	138	15	2	695[14]
Red gurnard	*Chelidonichthys kumu*	0.70[2]	0.49	186	29	2	1013
Hapuku	*Polyprion oxygeneios*	20.00[6]	14.00	186	63	2	1319
Trevally	*Pseudocaranx dentex*	1.60[5]	1.12	194	45	2	1189
Yellowtail kingfish	*Seriola lalandi*	3.90[5]	2.73	208	27	2	1083
Jack mackerel	*Trachurus declivis*	1.30[2]	0.91	186	59	2	1283
Horse mackerel	*Trachurus novaezelandiae*	1.00[2]	0.70	186	59	2	1283[15]
Carangidae	Carangidae ?sp	1.10[7]	0.77	196	44	2	1185[16]
Kahawai	*Arripis trutta*	1.80[4]	1.26	194	116	2	1828
Snapper	*Chrysophrys auratus*	2.20[3]	1.54	179	50	2	1174
Parore	*Girella tricuspidata*	0.70[4]	0.49	179	61	2	1273
Blue maomao	*Scorpis violacea*	0.70[4]	0.49	179	61	2	1273[17]
Marblefish	*Aplodactylus arctidens*	0.50[2]	0.35	173	30	2	970
Tarakihi	*Nemadactylus macropterus*	0.80[2]	0.56	189	108	2	1736
Porae	*Nemadactylus douglasi*	1.00[2]	0.70	197	92	2	1624
Red moki	*Goniistius spectabilis*	1.00[2]	0.70	189	108	2	1736[18]
Blue moki	*Latridopsis ciliaris*	2.70[2]	1.89	194	57	2	1297

Table 6 continued

Taxon		BWT kg	MTWT kg	Protein g/kg	Fat g/kg	Carb g/kg	Energy kcal/kg
Trumpeter	*Latris lineata*	3.00[2]	2.10	194	57	2	1297[19]
Grey mullet	*Mugil cephalus*	1.00[2]	0.70	195	107	2	1751
Yellow-eyed mullet	*Aldrichetta forsteri*	0.20[2]	0.14	182	46	2	1150
Wrasses	Labridae ?sp	1.50[8]	1.05	167	36	2	1000
Butterfish	*Odax pullus*	0.90[2]	0.63	167	36	2	1000
Black cods	Nototheniidae ?sp	1.60[8]	1.12	178	20	2	900[20]
Giant stargazer	*Kathetostoma giganteum*	1.30[2]	0.91	159	31	2	923
Spotted stargazer	*Genyagnus monopterygius*	0.50[2]	0.35	159	31	2	923[21]
Estuary stargazer	*Leptoscopus macropygus*	0.30[2]	0.21	159	31	2	923[21]
Blue cod	*Parapercis colias*	0.70[2]	0.49	178	20	2	900
Barracouta	*Thyrsites atun*	2.30[2]	1.61	184	45	2	1149
Gemfish	*Rexia solandri*	3.00[2]	2.10	179	64	2	1300
Blue mackerel	*Scomber australasicus*	1.00[2]	0.70	198	119	2	1871
Common warehou	*Seriolella brama*	2.30[2]	1.61	175	117	2	1761
Bluenose warehou	*Hyperoglyphe antarctica*	4.00[4]	2.80	180	51	2	1187
Lemon sole	*Pelotretis flavilatus*	0.50[8]	0.35	188	25	2	985
New Zealand sole	*Peltorhamphus novaezeelandiae*	0.50[8]	0.35	183	42	2	1118
Sole ?sp	*Pelotretis, Peltorhamphus* ?sp	0.50[7]	0.35	186	34	2	1052[22]
Yellowbelly flounder	*Rhombosolea leporina*	0.30[2]	0.21	186	25	2	977
Sand flounder	*Rhombosolea plebeia*	0.30[2]	0.21	176	24	2	928
Flounder ?sp	*Rhombosolea* ?sp	0.30[8]	0.21	181	25	2	953[23]
Brill	*Colistium guntheri*	0.50[8]	0.35	181	25	2	953[23]
Leatherjacket	*Meuschenia scaber*	0.80[2]	0.56	172	17	2	849
Fish ?sp	Fish ?sp	1.50[8]	1.05	180	50	2	1178[24]

Bodyweights from:
1– calculated from length data in FishBase; 2 – calculated from length data in Paul (2000); 3 – calculated from length data in Leach (2006);
4 – from weight data in FishBase; 5 – Vlieg (1998); 6 – Maxwell (2010); 7 – mean for relevant species; 8 – estimate
Nutritional and energy values from Vlieg (1998), using species measured, or:
9 – as for school shark; 10 – as for spiny dogfish; 11 – mean of shark/dogfish; 12 – as for swollenhead conger eel; 13 – as for red cod;
14 – as for sea perch; 15 – as for jack mackerel; 16 – mean of trevally, kingfish, jack mackerel; 17 – as for porae; 18 – as for tarakihi;
19 – as for blue moki; 20 – 12 for blue cod; 21 – as for giant stargazer; 22 – mean of two sole sp.; 23 – mean of two flounder sp.;
24 – mean of all bony fish.

Shellfish

Shellfish taxonomy follows Spencer et al. (2009), with several genus, family or other supra-species categories to accommodate individuals not able to be identified to species level. Taxa are listed in Table 7 alphabetically by genus/species (or other category name), and for some recently revised taxa previous nomenclature is included. Family names are also listed. The habitats that each species typically occurs in are also listed, as this information is often useful for archaeological analysis.

Mean wet meat weights were used directly as MTWT, with values taken from available sources, or estimated on the basis of shell sizes reported by Raven and Bracegirdle (2010), with all small shells estimated at 0.001kg (Table 7).

Vlieg (1998) undertook proximate analysis for nine shellfish taxa, and these values are used here, with the mean of those values used for all other taxa.

Table 7 Shellfish: meat weight (MTWT), nutritional and energy yields

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Acteonidae	*Acteonidae* ?sp		acteon	sandy	0.001	136	17	23	797
Buccinidae	*Aethocola glans*	*Austrofuscus glans*	knobbed whelk	sandy	0.002	136	17	23	797
Volutidae	*Alcithoe arabica*		arabic volute	mud/sand	0.003[3]	136	17	23	797
Olividae	*Amalda australis*		southern olive shell	sandy	0.001	136	17	23	797
Olividae	*Amalda murcronata*		brown olive shell	sandy	0.001	136	17	23	797
Olividae	*Amalda* ?sp		olive shell sp.	sandy	0.001	136	17	23	797
Amphibolidae	*Amphibola crenata*		mudsnail	mudflat	0.001[2]	136	17	23	797
Chitonidae	*Amuarochiton glaucus*		green chiton	rocky	0.001	136	17	23	797
Anomiidae	*Anomia trigonopsis*		golden oyster	rocky	0.001	136	17	23	797
Dentaliidae	*Antalis nana*		tusk shell		0.001	136	17	23	797
Dentaliidae	*Antalis* ?sp		tusk shell		0.001	136	17	23	797
Trochidae	*Antisolarium egenum*		antisolarium	sandy	0.001	136	17	23	797
Ranellidae	*Argobuccinum pustulosum tumidum*		swollen trumpet shell	rocky	0.002	136	17	23	797
Lottiidae	*Asteracmea suteri*		asteracmea	rocky	0.001	136	17	23	797
Lottiidae	*Atalacmea fragilis*			rocky	0.001	136	17	23	797
Lottiidae	*Atalacmea multilinea*			rocky	0.001	136	17	23	797
Pinnidae	*Atrina zelandica*		horse mussel	mud-subtidal	0.003[3]	148	5	24	730[4]
Mytilidae	*Aulacomya maoriana*	*Aulacomya ater maoriana*	ribbed mussel	rocky	0.002[3]	136	17	23	797
Littorinidae	*Austrolittorina cincta*	*Nodilittorina cincta*	periwinkle	rocky	0.001	136	17	23	797
Costellaridae	*Austromitra rubiginosa*		austomitra	sandy	0.001	136	17	23	797
Veneridae	*Austrovenus stutchburyi*		cockle	mudflat	0.002[2]	82	9	6	430[4]
Arcidae	*Barbatia novaezealandiae*		ark shell	rocky	0.001	136	17	23	797
Pholadidae	*Barnea similis*		rock borer	rocky	0.001	136	17	23	797
Siphonariidae	*Benhamina obliquata*		limpet B. obliquata	rocky	0.002	136	17	23	797
Cancellariidae	*Bonellitia superstes*		bonellitia	deep	0.001	136	17	23	797
Epitoniidae	*Boreoscala zelebori*	*Cirsotrema zelebori*	curly/wentle-trap	sandy	0.001	136	17	23	797
Buccinidae	*Buccinulum linea*		many-lined whelk	rocky	0.002	136	17	23	797
Buccinidae	*Buccinulum pallidum powelli*		lined whelk	rocky	0.002	136	17	23	797
Buccinidae	*Buccinulum vittatum littorinoides*		whelk B.v.littorinoides	rocky	0.001	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Buccinidae	*Buccinulum vittatum vittatum*		whelk B.v.vittatum	rocky	0.001	136	17	23	797
Buccinidae	*Buccinulum* ?sp		whelk Buccinulum ?sp	rocky	0.001	136	17	23	797
Bullidae	*Bulla quoyii*		brown bubble shell	mudflat	0.001	136	17	23	797
Ranellidae	*Cabestana spengleri*		spenglers trumpet shell	rocky	0.003	136	17	23	797
Calliostomatidae	*Calliostoma pellucidum*		maurea	sandy	0.001	136	17	23	797
Calliostomatidae	*Calliostoma punctulatum*		spotted tiger shell	rocky	0.001	136	17	23	797
Calliostomatidae	*Calliostoma selectum*		pale tiger shell	sandy	0.001	136	17	23	797
Calliostomatidae	*Calliostoma tigris*		tiger shell	rocky	0.002	136	17	23	797
Trochidae	*Cantharidius sanguineus*	*Micrelenchus sanguineus*	oval top shell	rocky	0.001	136	17	23	797
Trochidae	*Cantharidus purpureus*		purple top shell	rocky	0.001	136	17	23	797
Trochidae	*Cantharidus tenebrosus*	*Micrelenchus tenebrosus*	opal top shell	rocky	0.001	136	17	23	797
Trochidae	*Cantharidus* ?sp	*Micrelenchus* ?sp	topshell sp.	rocky	0.001	136	17	23	797
Carditidae	*Cardita aoteana*		nestling cockle/dog foot cockle	rocky	0.001	136	17	23	797
Nacellidae	*Cellana denticulata*		denticulate limpet	rocky	0.002[2]	136	17	23	797
Nacellidae	*Cellana flava*		golden limpet	rocky	0.002	136	17	23	797
Nacellidae	*Cellana ornata*		ornate limpet	rocky	0.001[1]	136	17	23	797
Nacellidae	*Cellana radians*		radiate limpet	rocky	0.002[1]	136	17	23	797
Nacellidae	*Cellana stellifera*		star limpet	rocky	0.001	136	17	23	797
Nacellidae	*Cellana strigilis*		strigils limpet	rocky	0.002	136	17	23	797
Nacellidae	*Cellana* ?sp		limpet Cellana ?sp	rocky	0.002	136	17	23	797
Ranellidae	*Charonia lampas*		trumpet shell	rocky	0.003	136	17	23	797
Veneridae	*Circomphalus yatei*	*Bassina yatei*	frilled venus	sandy	0.001	136	17	23	797
Trochidae	*Coelotrochus tiaratus*	*Trochus tiaratus*	tiara topshell	mudflat	0.001	136	17	23	797
Trochidae	*Coelotrochus viridius*	*Trochus viridius*	green top shell	rocky	0.001	136	17	23	797
Buccinidae	*Cominella adspersa*		speckled whelk	mudflat	0.002	136	17	23	797
Buccinidae	*Cominella glandiformis*		purple-mouthed whelk	mudflat	0.001	136	17	23	797
Buccinidae	*Cominella maculosa*		spotted whelk	mud/rock	0.002	136	17	23	797
Buccinidae	*Cominella quoyana quoyana*		quoy's whelk	sandy	0.001	136	17	23	797
Buccinidae	*Cominella virgata*		red mouthed whelk	rocky	0.001	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Buccinidae	*Cominella* ?sp		whelk Cominella ?sp		0.001[3]	136	17	23	797
Turbinidae	*Cookia sulcata*		cooks turban	rocky	0.015[1]	136	17	23	797
Ostreidae	*Crassostrea gigas*		pacific oyster	rocky	0.002[3]	131	32	9	860[4]
Mactridae	*Crassula aequilatera*	*Spisula aequilatera*	triangle shell	sandy	0.001	136	17	23	797
Mactridae	*Cyclomactra ovata*		oval trough shell	mudflat	0.002	136	17	23	797
Ranellidae	*Cymatium parthenopeum*		hairy triton	rocky	0.002	136	17	23	797
Muricidae	*Dicathais orbita*		white rock shell	rocky	0.015	136	17	23	797
Trochidae	*Diloma aethiops*	*Melagraphia aethiops*	spotted top shell	rocky	0.002[1]	136	17	23	797
Trochidae	*Diloma arida*		topshell D. arida	rocky	0.001	136	17	23	797
Trochidae	*Diloma bicanaliculata*		knobbed topshell	rocky	0.001	136	17	23	797
Trochidae	*Diloma nigerrima*		bluish top shell	rocky	0.001	136	17	23	797
Trochidae	*Diloma subrostrata*		mudflat top shell	mudflat	0.001	136	17	23	797
Trochidae	*Diloma zelandica*		topshell D.zelandica	rocky	0.001	136	17	23	797
Trochidae	*Diloma* ?sp	*Zediloma* ?sp	topshell Diloma ?sp		0.001	136	17	23	797
Unguliniudae	*Diplodonta striatula*		diplodonta	sandy	0.001	136	17	23	797
Lucinidae	*Divalucina cumingi*	*Divaricella huttoniana*	lace cockle	sandy	0.001	136	17	23	797
Veneridae	*Dosina zealandica*		coarse dosina	mud-subtidal	0.002	136	17	23	797
Veneridae	*Dosinia anus*		ringed venus shell	sandy	0.002	136	17	23	797
Veneridae	*Dosinia lambata*		silky dosinia	mud-subtidal	0.001	136	17	23	797
Veneridae	*Dosinia subrosea*		fine dosinia	sandy	0.002	136	17	23	797
Veneridae	*Dosinia* ?sp		venus shell	mud/sand	0.002[3]	136	17	23	797
Fissurellidae	*Emarginula striatula*		slit limpet	rocky	0.001	136	17	23	797
Fissurellidae	*Emarginula* ?sp		slit limpet Emarginula ?sp	rocky	0.001	136	17	23	797
Limidae	*Escalima regularis*		escalima	deep	0.001	136	17	23	797
Callochitonidae	*Eudoxochiton nobilis*		noble chiton	rocky	0.015[1]	136	17	23	797
Unguliniudae	*Felaniella zelandica*		fellaniella	sandy	0.001	136	17	23	797
Psammobiidae	*Gari lineolata*		pink sunset shell	sandy	0.001	136	17	23	797
Psammobiidae	*Gari stangeri*		purple sunset shell	sandy	0.001	136	17	23	797
	gastropod ?sp		gastropod ?sp		0.001	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Glycermididae	*Glycermis modesta*		small dog cockle	sandy	0.001	136	17	23	797
Haliotidae	*Haliotis australis*		silver paua	rocky	0.100	208	10	9	990[4]
Haliotidae	*Haliotis iris*		paua	rocky	0.150[1]	208	10	9	990[4]
Haliotidae	*Haliotis virginea*		virgin paua	rocky	0.050[1]	208	10	9	990[4]
Haliotidae	*Haliotis* ?sp		paua sp.	rocky	0.100	208	10	9	990[4]
Haminoeidae	*Haminoea zelandiae*		white bubble shell	mudflat	0.001	136	17	23	797
Muricidae	*Haustrum haustorium*		dark rock shell	rocky	0.015[1]	136	17	23	797
Muricidae	*Haustrum lacunosum*	*Lepsithais lacunosum*	white whelk	rocky	0.002	136	17	23	797
Muricidae	*Haustrum scobina*	*Lepisella scobina*	oyster borer	rocky	0.001	136	17	23	797
Chilodontidae	*Herpetopoma bella*		top shell	rocky	0.001	136	17	23	797
Veneridae	*Irus reflexus*		irregular cockle	sandy	0.001	136	17	23	797
Janthinidae	*Janthina janthina*	*Janthina violacea*	violet snail	deep	0.001	136	17	23	797
Velutinidae	*Lamellaria ophione*		lamellaria	sandy	0.001	136	17	23	797
Lasaeidae	*Lasaea hinemoa*	*Lasaea rubra*	mussel-like sp	sandy	0.001	136	17	23	797
Limidae	*Limatula maoria*		little file shell	sandy	0.001	136	17	23	797
Mytilidae	*Limnoperna pulex*	*Xenostrobus pulex*	little black mussel	rocky	0.001	136	17	23	797
	limpet ?sp		limpet ?sp	rocky	0.001	136	17	23	797
Nuculidae	*Linucula hartvigiana*	*Nucula hartvigiana*	nut shell	sandy	0.001	136	17	23	797
Littorinidae	Littorinidae sp	Nodilittorina ?sp	periwinkle Littorinidae ?sp	rocky	0.001	136	17	23	797
Turbinidae	*Lunella smaragdus*	*Turbo smaragdus*	cats eye	rocky	0.004[1]	136	17	23	797
Tellinidae	*Macomona liliana*	*Tellina lilliana*	large wedge shell	mud/sand	0.002[3]	136	17	23	797
Mactridae	*Mactra discors*		large trough shell	sandy	0.003[3]	136	17	23	797
Mactridae	*Mactra* ?sp		trough shell ?sp	sandy	0.003	136	17	23	797
Turritellidae	*Maoricolpus roseus*		turret shell	mud/rock/ sand	0.001	136	17	23	797
Calyptraeidae	*Maoricrypta costata*	*Crepidula costata*	ribbed slipper shell	rocky	0.002	136	17	23	797
Calyptraeidae	*Maoricrypta monoxyla*	*Crepidula monoxyla*	white slipper shell	rocky	0.001	136	17	23	797
Calyptraeidae	*Maoricrypta* ?sp	*Crepidula* ?sp	slipper shell ?sp	rocky	0.002	136	17	23	797
Turbinidae	*Modelia granosa*		southern cats eye	rocky	0.003	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Mytilidae	*Modiolus areolatus*		bearded mussel	rocky	0.003[3]	136	17	23	797
	Mollusca ?sp		shellfish ?sp		0.001	136	17	23	797
Muricidae	*Murexsul mariae*	*Muricopsis espinosus mariae*	muricopsis	rocky	0.001	136	17	23	797
Muricidae	*Murexsul octogonus*	*Muricopsis octogonus*	octagonal murex	rocky	0.002	136	17	23	797
Muricidae	Muricidae ?sp		muricid ?sp	rocky	0.001	136	17	23	797
Mytilidae	*Musculus impacta*	*Modiolarca impacta*	nesting mussel	rocky	0.001	136	17	23	797
Myochamidae	*Myadora striata*		battleaxe	sandy	0.001	136	17	23	797
Lasaeidae	*Myllita stowei*		myllita	sandy	0.001	136	17	23	797
Mytilidae	Mytilidae ?sp		mussel ?sp	rocky	0.001	136	17	23	797
Mytilidae	*Mytilus galloprovincialis*		blue mussel	rocky	0.003[2]	136	17	23	797
Malletiidae	*Neilo australis*		mallet shell	deep-muddy	0.001	136	17	23	797
Raphitomidae	*Neoguraleus* ?sp		neoguraleus	sandy	0.001	136	17	23	797
Neritidae	*Nerita atramentosa*		black nerita	rocky	0.001	136	17	23	797
Lottiidae	*Notoacmea badia*		limpet N.badia	rocky	0.001	136	17	23	797
Lottiidae	*Notacmea cellanaoides*		limpet N.cellanoides	rocky	0.001	136	17	23	797
Lottiidae	*Notoacmea daedala*		limpet N.daedala	rocky	0.001	136	17	23	797
Lottiidae	*Notoacmea elongata*	*Notoacmea helmsi*	limpet N.elongata	rocky	0.001	136	17	23	797
Lottiidae	*Notoacmea parviconoidea*		limpet N. parviconicoidea	rocky	0.001	136	17	23	797
Lottiidae	*Notoacmea pileopsis*		black edged limpet	rocky	0.001	136	17	23	797
Lottiidae	*Notoacmea scopulina*		limpet N.scopulina	rocky	0.001	136	17	23	797
Ostreidae	*Ostrea chilensis*		mud oyster/bluff oyster	mud/rock	0.002	129	30	31	1030[4]
Mactridae	*Oxyperas elongata*		elongated mactra	sandy	0.002	136	17	23	797
Ostreidae	oyster ?sp		oyster ?sp		0.002[1]	136	17	23	797
Hiatellidae	*Panopea zelandica*		deep burrower	sandy	0.002	136	17	23	797
Mesodesmatidae	*Paphies australis*		pipi	mud/sand	0.001[2]	82	7	5	410[4]
Mesodesmatidae	*Paphies subtriangulata*		tuatua	sandy	0.002[3]	167	22	62	1100[4]
Mesodesmatidae	*Paphies ventricosa*		toheroa	sandy	0.004[3]	136	17	23	797
Mesodesmatidae	*Paphies* ?sp		paphies ?sp	sandy	0.001	136	17	23	797
Muricidae	*Paratrophon patens*		rock trophon	rocky	0.001	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Muricidae	*Paratrophon quoyi*		Stanger's trophon	rocky	0.001	136	17	23	797
Patellacea	Patellacea ?sp		limpet Patellacea ?sp	rocky	0.001	136	17	23	797
Lottiidae	*Patelloida corticata*		encrusted limpet	rocky	0.001	136	17	23	797
Pectinidae	*Pecten novaezelandiae*		queen scallop	sandy	0.003[3]	136	17	23	797
Pectinidae	*Pecten* ?sp		scallop ?sp	sandy	0.001	154	13	27	830[4]
Struthiolariidae	*Pelicaria vermis*		small ostrich foot	sandy	0.001	136	17	23	797
Buccinidae	*Penion sulcatus*		siphon whelk	rocky	0.003	136	17	23	797
Buccinidae	*Penion* ?sp		siphin whelk ?sp	rocky	0.001	136	17	23	797
Mytilidae	*Perna canaliculus*		green-lipped mussel	rocky	0.004[3]	119	21	34	790[4]
Tellinidae	*Peronaea gaimardi*		angled wedge shell	sandy	0.001	136	17	23	797
Terebridae	*Pervicacea tristis*		NZ auger	sandy	0.001	136	17	23	797
Clathurellidae	*Phenatoma rosea*		pink tower shell	sandy	0.001	136	17	23	797
Naticidae	*Polinices* ?sp		naticid ?sp	sandy	0.001	136	17	23	797
	Polyplacophora ?sp		chiton ?sp	rocky	0.001	136	17	23	797
Hydrobiidae	*Potamopyrgus antipodarum*		NZ mud snail	mudflat	0.001	136	17	23	797
Cardiidae	*Pratulum pulchellum*	*Nemocardium pulchellum*	heart cockle	sandy	0.001	136	17	23	797
Veneridae	*Protothaca crassicostata*		ribbed venus	mud/sand	0.001[3]	136	17	23	797
Tellinidae	*Pseudocopagia disculus*		round wedge shell	mud/sand	0.001	136	17	23	797
Carditidae	*Purpurocardia purpurata*		purple cockle	sandy	0.001	136	17	23	797
Carditidae	*Purpurocardia* ?sp		false cockle sp	sandy	0.001	136	17	23	797
Lottiidae	*Radiacmea inconspicua*		limpet R.inconspicua	rocky	0.001	136	17	23	797
Ranellidae	*Ranella australasia*		Australian triton	rocky	0.002	136	17	23	797
Mactridae	*Resania lanceolata*		lance mactra	sandy	0.002	136	17	23	797
Littorinidae	*Risellopsis varia*		riseellopsis	rocky	0.001	136	17	23	797
Rissoidae	*Rissoina* ?sp		rissoinia ?sp	sandy	0.001	136	17	23	797
Veneridae	*Ruditapes largillierti*		oblong venus	mud/sand	0.001	136	17	23	797
Ostreidae	*Saccostrea cucullata glomerata*	*Saccostrea glomerata*	rock oyster	rocky	0.001	136	17	23	797
Fissurellidae	*Scutus breviculus*		shield limpet	rocky	0.015[1]	136	17	23	797
Cassidae	*Semicassis pyrum*		helmet shell	sandy	0.002	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Vermetidae	*Serpulorbis* ?sp		worm snail ?sp		0.001	136	17	23	797
Tellinidae	*Serratina charlottae*	*Tellina charlottae*	wedge shell	deep	0.002	136	17	23	797
Calyptraeidae	*Sigapatella novaezelandiae*		circular slipper shell	rocky	0.002	136	17	23	797
Calyptraeidae	*Sigapatella tenuis*	*Zegalerus tenuis*	small circular slipper shell	rocky	0.001	136	17	23	797
Siphonariidae	*Siphonaria australis*		siphon limpet S.australis	rocky	0.001[1]	136	17	23	797
Siphonariidae	*Siphonaria propria*		siphon limpet S.propria	rocky	0.001	136	17	23	797
Siphonariidae	*Siphonaria* ?sp		siphon limpet ?sp	rocky	0.001	136	17	23	797
	small mudshell ?sp		small mudshell	muddy	0.001	136	17	23	797
Solemyidae	*Solemya parkinsonii*		razor mussel	mudflat	0.001	136	17	23	797
Psammobiidae	*Solletellina nitida*		shining sunset shell	sandy	0.001	136	17	23	797
Struthiolariidae	*Struthiolaria papulosa*		ostrich foot	mud/sand	0.002	136	17	23	797
Struthiolariidae	*Strutholaria* ?sp		ostrich foot? sp	mud/sand	0.002	136	17	23	797
Pectinidae	*Talochlamys zelandiae*	*Chlamys zelandiae*	fan scallop	rocky	0.001	136	17	23	797
Naticidae	*Tanea zelandica*		necklace shell	sandy	0.001	136	17	23	797
Fasciolariidae	*Taron* ?sp		whelk taron ?sp	rocky	0.001	136	17	23	797
Veneridae	*Tawera spissa*		morning star	sandy	0.001	136	17	23	797
Veneridae	*Tawera* ?sp		venus shell sp.	sandy	0.001	136	17	23	797
Trimusculidae	*Trimusculus conicus*		false limpet	rocky	0.001	136	17	23	797
Trochidae	Trochidae ?sp		topshell ?sp		0.001	136	17	23	797
Glycermididae	*Tucetona laticostata*		large dog cockle	sandy	0.001	136	17	23	797
Fissurellidae	*Tugali elegans*		grooved limpet	rocky	0.001	136	17	23	797
Pyrimidellidae	*Turbonilla zealandica*	*Chemnitzia zealandica*	turbonilla	sandy	0.001	136	17	23	797
Buccinidae	whelk ?sp		whelk ?sp		0.001	136	17	23	797
Muricidae	*Xymene ambiguous*		large trophon	mud/sand	0.001	136	17	23	797
Muricidae	*Xymene huttoni*		trophon X.huttoni	mud/sand	0.001	136	17	23	797
Muricidae	*Xymene plebeius*		trophon X.plebius	mudflat	0.001	136	17	23	797
Muricidae	*Xymene traversi*		trophon X.traversi	sandy	0.001	136	17	23	797
Muricidae	*Xymene* ?sp		trophon ?sp		0.001	136	17	23	797
Turritellidae	*Zeacolpus pagoda*		pagoda turret shell	sandy	0.001	136	17	23	797

Table 7 continued

Family	Species name	Previous nomenclature	Common Name	Habitat	MTWT kg	protein g/kg	fat g/kg	carb g/kg	energy kcal/kg
Turritellidae	*Zeacolpus symmetricus*		Stewart Island turret shell	sandy	0.001	136	17	23	797
Batillariidae	*Zeacumantus lutulentus*		horn shell	mudflat	0.001	136	17	23	797
Batillariidae	*Zeacumantus subcarinatus*		brown horn shell	mudflat	0.001	136	17	23	797
Batillariidae	*Zeacumantus* ?sp		horn shell ?sp	mudflat	0.001	136	17	23	797
Mytilidae	*Zelithophaga truncata*		date mussel	rocky	0.001	136	17	23	797
Columbellidae	*Zemitrella* ?sp		zemitrella ?sp	sandy	0.001	136	17	23	797
Mactridae	*Zenatia acinaces*		scimitar mactra	sandy	0.002	136	17	23	797
Trochidae	*Zethalia zelandica*	*Umbonium zelandica*	wheel shell	sandy	0.001	136	17	23	797

MTWT from: 1 – Anderson 1981a: Table 2; 2 – Anderson 1981b: Table 8; 3 – Smith 1985: Table 99; all others are estimates based on shell size.
Nutritonal and energy values from: 4 – Vlieg 1988: Table 6, 8; all others based on mean of measured shellfish values.

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