

TABLE 18-1 Nutrient Requirements of Freshwater Fish (dry-matter basis)<sup>a,b</sup>

Item	Atlantic Salmon <i>Salmo salar</i>	Common Carp <i>Cyprinus carpio</i>	Rohu <i>Labeo rohita</i>	Tilapia <i>Oreochromis</i> spp.	Channel Catfish <i>Ictalurus punctatus</i>	Hybrid Striped Bass <i>Morone saxatilis</i> × <i>Morone chrysops</i>	Rainbow Trout <i>Oncorhynchus mykiss</i>	Pacific Salmon <i>Oncorhynchus</i> spp.
<b>Typical Energy and Protein Concentrations<sup>c</sup></b>								
Digestible energy (kcal/kg diet)	4,400	3,200	3,200	3,400	3,000	4,000	4,200	4,200
Digestible protein (%)	36	32	32	29	29	36	38	40
<b>Nutrient Requirements</b>								
<b>Amino acids (%)</b>								
Arginine	1.8	1.7	1.7	1.2	1.2	1.0	1.5	2.2
Histidine	0.8 <sup>d</sup>	0.5	0.9	1.0	0.6	NT	0.8	0.7
Isoleucine	1.1	1.0	1.0	1.0	0.8	NT	1.1	1.0
Leucine	1.5	1.4	1.5	1.9	1.3	NT	1.5	1.6
Lysine	2.4	2.2	2.3	1.6	1.6	1.6	2.4	2.2
Methionine	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7
Methionine + cystine	1.1	1.0	1.0	1.0	0.9	1.1	1.1	1.1
Phenylalanine	0.9	1.3	0.9	1.1	0.7	0.9	0.9	0.9
Phenylalanine + tyrosine	1.8	2.0	1.6	1.6	1.6	NT	1.8	1.8
Threonine	1.1	1.5	1.7	1.1	0.7	0.9	1.1	1.1
Tryptophan	0.3	0.3	0.4	0.3	0.2	0.3	0.3	0.3
Valine	1.2	1.4	1.5	1.5	0.8	NT	1.2	1.2
Taurine	NR	NR	NT	NT	NR	NR	NR <sup>e</sup>	NT
<b>Fatty acids (%)</b>								
18:3n-3	1.0	0.5–1.0	NT	NT	1.0–2.0	NR	0.7–1.0	1.0
n-3 LC-PUFA <sup>f</sup>	0.5–1.0	R	NT	R	0.5–0.75	0.5–1.0	0.4–0.5	1.0
18:2n-6	NT	1.0	NT	0.5–1.0	NT	NT	1.0	1.0
<b>Cholesterol (%)</b>	NT	NT	NT	NT	NT	NT	NT	NT
<b>Phospholipids (%)</b>	NT (4.0–6.0) <sup>g</sup>	NT (2.0) <sup>g</sup>	NT	NT	NT	NT	NT (4.0–14.0) <sup>g</sup>	NT
<b>Macrominerals (%)</b>								
Calcium	NR	0.34	NT	R/0.7 <sup>h</sup>	R/0.45 <sup>h</sup>	NR	NR	NR
Chlorine	NT	NT	NT	0.15	0.17	NT	NT	NT
Magnesium	0.04	0.05	NT	0.06	0.04	NT	0.05	NT
Phosphorus	0.80	0.70	NT	0.40	0.33	0.50	0.70	0.60
Potassium	NT	NT	NT	0.20–0.30	0.26	NT	NT	0.80
Sodium	NR	NT	NT	0.15	0.06	NT	NR	NT
<b>Microminerals (mg/kg)</b>								
Copper	5	3	NT	5	5	NT	3	NT
Iodine	R	NT	NT	NT	1.1	NT	1.1	I
Iron	30–60	150	NT	85	30	NT	NT	NT
Manganese	10	12	NT	7	2.4	NT	12	NT
Selenium	NT	NT	NT	NT	0.25	0.25	0.15	R
Zinc	37	15	NT	20	20	37	15	NT
<b>Fat-soluble vitamins<sup>i</sup></b>								
A (mg/kg)	NT	1.2	NT	1.8	0.6	0.5	0.75	R
D (µg/kg)	NT	NT	NT	9	12.5	NT	40	NR
E (mg/kg)	60	100	132	60	50	28	50	50
K (mg/kg)	< 10	NT	NT	NT	R	NT	R	R

continued

TABLE 18-2 Nutrient Requirements of Marine Fish (dry-matter basis)<sup>a,b</sup>

Item	Asian Sea Bass (Barramundi) <i>Lates calcarifer</i>	Cobia <i>Rachycentron canadum</i>	European Sea Bass <i>Dicentrarchus labrax</i>	Japanese Flounder <i>Paralichthys olivaceus</i>	Grouper <i>Epinephelus spp.</i>	Red Drum <i>Sciaenops ocellatus</i>	Yellowtail <i>Seriola spp.</i>
<b>Typical Energy and Protein Concentrations<sup>c</sup></b>							
Digestible energy (kcal/kg diet)	4,200	4,200	4,000	4,000	4,000	4,000	4,200
Digestible protein (%)	38	38	40	40	42	36	38
<b>Nutrient Requirements</b>							
<b>Amino acids (%)</b>							
Arginine	1.8	NT	1.8	2.0	NT	1.8	1.6
Histidine	NT	NT	NT	NT	NT	NT	NT
Isoleucine	NT	NT	NT	NT	NT	NT	NT
Leucine	NT	NT	NT	NT	NT	NT	NT
Lysine	2.1	2.3	2.2	2.6	2.8	1.7	1.9
Methionine	0.8	0.8	NT	0.9	NT	0.8	0.8
Methionine + cystine	1.2	1.1	1.1	NT	NT	1.2	1.2
Phenylalanine	NT	NT	NT	NT	NT	NT	NT
Phenylalanine + tyrosine	NT	NT	NT	NT	NT	NT	NT
Threonine	NT	NT	1.2	NT	NT	0.8	NT
Tryptophan	NT	NT	0.3	NT	NT	NT	NT
Valine	NT	NT	NT	NT	NT	NT	NT
Taurine <sup>d</sup>	R	R	0.2	R	R	R	R
<b>Fatty acids (%)</b>							
18:3n-3	NT	NT	NR	NT	NT	NR	NT
n-3 LC-PUFA <sup>e</sup>	NT	NT	1.0	1.4	1.0	0.5-1.0	2.0-3.9
18:2n-6	NT	NT	NT	NT	NT	NT	NT
<b>Cholesterol (%)</b>							
	NT	NT	NT	NT	NT	NT	NT
<b>Phospholipids (%)</b>							
	NT	NT	2-3 (12) <sup>f</sup>	7 (7) <sup>f</sup>	NT	NT	NT
<b>Macrominerals (%)</b>							
Calcium	NT	NT	NT	NT	NT	NT	NT
Chlorine	NT	NT	NT	NT	NT	R	NT
Magnesium	NT	NT	NT	NT	NT	NT	NT
Phosphorus	NT	NT	0.65	0.60	NT	0.80	NT
Potassium	NT	NT	NT	NT	NT	NT	NT
Sodium	NT	NT	NT	NT	NT	R	NT
<b>Microminerals (mg/kg)</b>							
Copper	NT	NT	NT	NT	5	NT	NT
Iodine	NT	NT	NT	NT	NT	NT	NT
Iron	NT	NT	NT	NT	NT	NT	NT
Manganese	NT	NT	NT	NT	NT	NT	NT
Selenium	NT	NT	NT	NT	0.7	NT	NT
Zinc	NT	NT	NT	NT	NT	20	NT
<b>Fat-soluble vitamins<sup>g</sup></b>							
A (mg/kg)	NT	NT	31	2.7	0.9	NT	5.6
D (µg/kg)	NT	NT	NT	NT	NT	NT	NR
E (mg/kg)	NT	NT	NT	NT	115	31	119
K (mg/kg)	NT	NT	NT	NT	NT	NT	NR

continued