Supplementary Figure S1. Relative abundance of the major bacterial phyla found in Alaskan brown bears (*Ursus arctos*) across percent body fat categories: below median, median, and above median. We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S2. Relative abundance of the major bacterial phyla found in Alaskan brown bears (*Ursus arctos*) across percent net body mass categories: below median, median, and above median. We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S3. Relative abundance of the major bacterial phyla found in Alaskan brown bears (Ursus arctos) across fat mass categories: below median, median, and above median. We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S4. Relative abundance of the major bacterial phyla found in Alaskan brown bears (Ursus arctos) across lean mass categories: below median, median, and above median. We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S5. Relative abundance of the major bacterial genera found across percent body fat categories in Alaskan brown bear (*Ursus arctos*). We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S6. Relative abundance of the major bacterial genera found across net body mass categories in Alaskan brown bear (*Ursus arctos*). We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S7. Relative abundance of the major bacterial genera found across lean mass categories in Alaskan brown bear (*Ursus arctos*). We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S8. Relative abundance of the major bacterial genera found across fat mass categories in Alaskan brown bear (*Ursus arctos*). We include all major taxa occurring at ≥1% relative abundance; “minor” taxa are those occurring at <1% relative abundance. Categorization of body metrics created using median splitting.
Supplementary Figure S9. Violin plots summarizing Faith’s phylogenetic diversity of brown bear (*Ursus arctos*) gut microbiomes for each body condition category: **a)** percent body fat; **b)** net body mass; **c)** fat mass; and **d)** lean mass.
Supplementary Figure S10. Gut microbial beta diversity among Alaskan brown bears (*Ursus arctos*). Principle Coordinate Analysis plots of weighted UniFrac distances in brown bears with varying a) percent body fat, b) net body mass, c) fat mass, and d) lean mass.
**Supplementary Figure S11.** Gut microbial beta diversity among Alaskan brown bears (*Ursus arctos*). Principle Coordinate Analysis plots of weighted UniFrac distances in brown bears with varying a) percent body fat, b) net body mass, c) fat mass, and d) lean mass.

**Supplementary Table S1.** Gut microbial community composition in Alaskan brown bear (*Ursus arctos*). Total relative abundance of major genera (≥1%) within bears sampled.

| Phylum          | Genus                   | Abundance | sd   | Total  |
|-----------------|-------------------------|-----------|------|--------|
| Actinobacteria  | Minor (total)           | 2.277%    | NA   | 2.277% |
| Bacteroidetes   | Minor (total)           | 2.098%    | NA   | 2.098% |
| Epsilonbacteraeota | *Helicobacter*          | 7.002%    | 14.027% | 7.263% |
|                 | Minor (total)           | 0.261%    | NA   | 0.261% |
| Firmicutes      | *Clostridium sensu stricio 1* | 8.901%    | 14.793% |
|                 | *Family Peptostreptococcaceae* | 2.304%    | 4.843% |
|                 | *Order Lactobacillales*  | 2.773%    | 6.825% |
|                 | *Romboutsia*            | 1.816%    | 5.702% | 49.458% |
|                 | *Streptococcus*         | 11.120%   | 18.692% |
|                 | *Terrisporobacter*      | 1.255%    | 2.540% |
|                 | *Turicibacter*          | 17.189%   | 24.334% |
| Phylum               | Taxon                      | Minor (total) | Abundance   | sd  | se  | ci  |
|----------------------|----------------------------|---------------|-------------|-----|-----|-----|
| Proteobacteria       | *Actinobacillus*           |               | 1.233%      | 4.659% | 8.436% | NA  |
|                      | *Escherichia-Shigella*     |               | 19.085%     | 24.621% | 31.181% | 4.659% |
|                      | *Family Enterobacteriaceae*|               | 2.427%      | 9.847% | NA  |     |
|                      | Minor (total)              |               |             |       |     |     |
| Tenericutes          | *Mycoplasma*               |               | 2.378%      | 8.507% |     |     |
|                      | *Ureaplasma*               |               | 3.071%      | 9.998% |     |     |
|                      | Minor (total)              |               | 0.022%      | NA    |     |     |
| Minor                | Minor (total)              |               | 2.252%      | NA    | 2.252% |     |

**Supplementary Table S2.** Mean abundance of the six major bacterial phyla (≥1% relative abundance) in brown bear (*Ursus arctos*) gut microbiomes among different body condition categories.

**a. Actinobacteria**

| Body Condition                  | N   | Abundance | sd  | se  | ci  |
|--------------------------------|-----|-----------|-----|-----|-----|
| Below Median Body Fat           | 29  | 0.031     | 0.058| 0.011| 0.022|
| Median Body Fat                 | 17  | 0.018     | 0.030| 0.007| 0.015|
| Above Median Body Fat           | 6   | 0.013     | 0.009| 0.004| 0.010|
| Below Median Net Mass           | 27  | 0.030     | 0.059| 0.011| 0.023|
| Median Net Mass                 | 24  | 0.021     | 0.030| 0.006| 0.013|
| Above Median Net Mass           | 2   | 0.014     | 0.007| 0.005| 0.065|
| Below Median Lean Mass          | 22  | 0.037     | 0.064| 0.014| 0.028|
| Median Lean Mass                | 23  | 0.019     | 0.029| 0.006| 0.013|
| Above Median Lean Mass          | 7   | 0.008     | 0.007| 0.003| 0.006|
| Below Median Fat Mass           | 39  | 0.025     | 0.051| 0.008| 0.017|
| Median Fat Mass                 | 10  | 0.027     | 0.037| 0.012| 0.026|

**b. Bacteroidetes**

| Body Condition                  | N   | Abundance | sd  | se  | ci  |
|--------------------------------|-----|-----------|-----|-----|-----|
| Below Median Body Fat           | 29  | 0.023     | 0.055| 0.010| 0.021|
| Median Body Fat                 | 17  | 0.015     | 0.039| 0.009| 0.020|
| Above Median Body Fat           | 6   | 0.020     | 0.021| 0.008| 0.022|
| Below Median Net Mass           | 27  | 0.025     | 0.058| 0.011| 0.023|
| Median Net Mass                 | 24  | 0.024     | 0.053| 0.011| 0.022|
| Above Median Net Mass           | 2   | 0.013     | 0.006| 0.004| 0.051|
| Below Median Lean Mass          | 22  | 0.017     | 0.023| 0.005| 0.010|
| Median Lean Mass                | 23  | 0.026     | 0.067| 0.014| 0.029|
| Above Median Lean Mass          | 7   | 0.013     | 0.018| 0.007| 0.016|
| Below Median Fat Mass           | 39  | 0.018     | 0.048| 0.008| 0.016|
| Median Fat Mass                 | 10  | 0.032     | 0.049| 0.016| 0.035|

**c. Epsilonbacteraeota**

| Body Condition                  | N   | Abundance | sd  | se  | ci  |
|--------------------------------|-----|-----------|-----|-----|-----|
| Below Median Body Fat           | 29  | 0.083     | 0.151| 0.028| 0.057|
| Median Body Fat                 | 17  | 0.091     | 0.188| 0.046| 0.100|
| Body Condition                        | N  | Abundance | sd  | se  | ci  |
|--------------------------------------|----|-----------|-----|-----|-----|
| Above Median Body Fat                | 6  | 0.026     | 0.045| 0.018| 0.047|
| Below Median Net Mass                | 27 | 0.093     | 0.154| 0.030| 0.061|
| Median Net Mass                      | 24 | 0.061     | 0.161| 0.033| 0.068|
| Above Median Net Mass                | 2  | 0.059     | 0.082| 0.058| 0.737|
| Below Median Lean Mass               | 22 | 0.097     | 0.167| 0.036| 0.074|
| Median Lean Mass                     | 23 | 0.019     | 0.029| 0.006| 0.013|
| Above Median Lean Mass               | 7  | 0.154     | 0.271| 0.102| 0.251|
| Below Median Fat Mass                | 39 | 0.095     | 0.174| 0.028| 0.056|
| Median Fat Mass                      | 10 | 0.028     | 0.057| 0.018| 0.040|
| Above Median Fat Mass                | 3  | 0.042     | 0.065| 0.038| 0.162|

### d. Firmicutes

| Body Condition                        | N  | Abundance | sd  | se  | ci  |
|--------------------------------------|----|-----------|-----|-----|-----|
| Below Median Body Fat                | 29 | 0.458     | 0.332| 0.062| 0.127|
| Median Body Fat                      | 17 | 0.465     | 0.301| 0.073| 0.155|
| Above Median Body Fat                | 6  | 0.547     | 0.223| 0.091| 0.234|
| Below Median Net Mass                | 27 | 0.434     | 0.315| 0.061| 0.125|
| Median Net Mass                      | 24 | 0.473     | 0.312| 0.064| 0.132|
| Above Median Net Mass                | 2  | 0.721     | 0.262| 0.185| 2.353|
| Below Median Lean Mass               | 22 | 0.380     | 0.306| 0.065| 0.136|
| Median Lean Mass                     | 23 | 0.548     | 0.274| 0.057| 0.118|
| Above Median Lean Mass               | 7  | 0.503     | 0.386| 0.146| 0.357|
| Below Median Fat Mass                | 39 | 0.464     | 0.319| 0.051| 0.103|
| Median Fat Mass                      | 10 | 0.439     | 0.289| 0.092| 0.207|
| Above Median Fat Mass                | 3  | 0.662     | 0.212| 0.122| 0.526|

### e. Proteobacteria

| Body Condition                        | N  | Abundance | sd  | se  | ci  |
|--------------------------------------|----|-----------|-----|-----|-----|
| Below Median Body Fat                | 29 | 0.345     | 0.300| 0.056| 0.114|
| Median Body Fat                      | 17 | 0.350     | 0.288| 0.070| 0.148|
| Above Median Body Fat                | 6  | 0.285     | 0.171| 0.070| 0.179|
| Below Median Net Mass                | 27 | 0.342     | 0.284| 0.055| 0.112|
| Median Net Mass                      | 24 | 0.356     | 0.284| 0.058| 0.120|
| Above Median Net Mass                | 2  | 0.182     | 0.206| 0.146| 1.850|
| Below Median Lean Mass               | 22 | 0.388     | 0.290| 0.062| 0.129|
| Median Lean Mass                     | 23 | 0.322     | 0.263| 0.055| 0.114|
| Above Median Lean Mass               | 7  | 0.246     | 0.319| 0.121| 0.295|
| Below Median Fat Mass                | 39 | 0.342     | 0.292| 0.047| 0.095|
| Median Fat Mass                      | 10 | 0.352     | 0.275| 0.087| 0.197|
| Above Median Fat Mass                | 3  | 0.265     | 0.205| 0.118| 0.509|

### f. Tenericutes

| Body Condition                        | N  | Abundance | sd  | se  | ci  |
|--------------------------------------|----|-----------|-----|-----|-----|
| Below Median Body Fat                | 29 | 0.032     | 0.063| 0.012| 0.024|
| Median Body Fat                      | 17 | 0.043     | 0.094| 0.023| 0.048|
| Above Median Body Fat                | 6  | 0.094     | 0.229| 0.093| 0.240|
| Below Median Net Mass                | 27 | 0.047     | 0.121| 0.023| 0.048|
| Median Net Mass                      | 24 | 0.040     | 0.079| 0.016| 0.034|
| Below Median Lean Mass | 22 | 0.057 | 0.133 | 0.028 | 0.059 |
|------------------------|----|-------|-------|-------|-------|
| Median Lean Mass       | 23 | 0.024 | 0.065 | 0.014 | 0.029 |
| Above Median Lean Mass |  7 | 0.059 | 0.094 | 0.036 | 0.087 |
| Below Median Fat Mass  | 39 | 0.032 | 0.069 | 0.011 | 0.022 |
| Median Fat Mass        | 10 | 0.098 | 0.186 | 0.059 | 0.133 |

**Supplementary Table S3.** One-way analysis of variance test for significant differences in brown bear (*Ursus arctos*) gut microbiome major phyla abundance (≥1% relative abundance) between body metrics. No significant differences.

**a. Actinobacteria**

|             | df | Sum Sq | Mean Sq | F value | Pr(>F) |
|-------------|----|--------|---------|---------|--------|
| Body Fat    |  2 | 0.002  | 0.001   | 0.437   | 0.649  |
| Residuals   | 46 | 0.107  | 0.002   |         |        |
| Net Mass    |  2 | 0.001  | 0.001   | 0.182   | 0.834  |
| Residuals   | 47 | 0.110  | 0.002   |         |        |
| Lean Mass   |  2 | 0.005  | 0.003   | 1.134   | 0.331  |
| Residuals   | 46 | 0.104  | 0.002   |         |        |
| Fat Mass    |  2 | 0.001  | 0.001   | 0.124   | 0.884  |
| Residuals   | 46 | 0.109  | 0.002   |         |        |

**b. Bacteroidetes**

|             | df | Sum Sq | Mean Sq | F value | Pr(>F) |
|-------------|----|--------|---------|---------|--------|
| Body Fat    |  2 | 0.001  | 0.001   | 0.244   | 0.784  |
| Residuals   | 46 | 0.110  | 0.002   |         |        |
| Net Mass    |  2 | 0.001  | 0.001   | 0.062   | 0.94   |
| Residuals   | 47 | 0.148  | 0.003   |         |        |
| Lean Mass   |  2 | 0.002  | 0.001   | 0.327   | 0.723  |
| Residuals   | 46 | 0.110  | 0.002   |         |        |
| Fat Mass    |  2 | 0.002  | 0.001   | 0.370   | 0.693  |
| Residuals   | 46 | 0.110  | 0.002   |         |        |

**c. Epsilonbacteraeota**

|             | df | Sum Sq | Mean Sq | F value | Pr(>F) |
|-------------|----|--------|---------|---------|--------|
| Body Fat    |  2 | 0.024  | 0.012   | 0.457   | 0.636  |
| Residuals   | 46 | 1.186  | 0.026   |         |        |
| Net Mass    |  2 | 0.007  | 0.004   | 0.144   | 0.866  |
| Residuals   | 47 | 1.201  | 0.026   |         |        |
| Lean Mass   |  2 | 0.068  | 0.034   | 1.364   | 0.266  |
| Residuals   | 46 | 1.141  | 0.025   |         |        |
| Fat Mass    |  2 | 0.040  | 0.020   | 0.778   | 0.465  |
| Residuals   | 46 | 1.170  | 0.025   |         |        |
### d. Tenericutes

|                | df | Sum Sq | Mean Sq | F value | Pr(>F) |
|----------------|----|--------|---------|---------|---------|
| Body Fat       | 2  | 0.078  | 0.039   | 2.412   | 0.114   |
| Residuals      | 21 | 0.341  | 0.016   |         |         |
| Net Mass       | 2  | 0.024  | 0.024   | 1.377   | 0.253   |
| Residuals      | 23 | 0.403  | 0.018   |         |         |
| Lean Mass      | 2  | 0.052  | 0.026   | 1.491   | 0.248   |
| Residuals      | 21 | 0.367  | 0.017   |         |         |
| Fat Mass       | 2  | 0.040  | 0.040   | 2.315   | 0.142   |
| Residuals      | 22 | 0.380  | 0.017   |         |         |

**Supplementary Table S4.** Kruskal-Wallis rank sum test for significant differences in brown bear (*Ursus arctos*) gut microbiome major phyla abundance (≥1% relative abundance) between body metrics for non-parametric data. P-value adjusted with Bonferroni correction. No significant differences.

### a. Firmicutes

|                | K-W chi-squared | df | P value |
|----------------|-----------------|----|---------|
| Body Fat       | 0.489           | 2  | 0.783   |
| Net Mass       | 1.621           | 2  | 0.445   |
| Lean Mass      | 3.414           | 2  | 0.181   |
| Fat Mass       | 1.288           | 2  | 0.525   |

### b. Proteobacteria

|                | K-W chi-squared | df | P value |
|----------------|-----------------|----|---------|
| Body Fat       | 0.065           | 2  | 0.968   |
| Net Mass       | 0.814           | 2  | 0.666   |
| Lean Mass      | 2.316           | 2  | 0.314   |
| Fat Mass       | 0.184           | 2  | 0.912   |

**Supplementary Table S5.** Mean abundance of the five dominant bacterial phyla abundance (≥10% mean abundance) in brown bear (*Ursus arctos*) gut microbiomes among different body condition categories.

### a. *Escherichia-Shigella*

| Body Condition         | N  | Abundance | sd  | se  | ci  |
|------------------------|----|-----------|-----|-----|-----|
| Below Median Body Fat  | 29 | 0.245     | 0.295 | 0.055 | 0.112 |
| Median Body Fat        | 17 | 0.155     | 0.222 | 0.054 | 0.114 |
| Above Median Body Fat  | 6  | 0.167     | 0.180 | 0.074 | 0.189 |
| Below Median Net Mass  | 27 | 0.257     | 0.289 | 0.056 | 0.114 |
| Median Net Mass        | 24 | 0.153     | 0.227 | 0.046 | 0.098 |
| Above Median Net Mass  | 2  | 0.066     | 0.061 | 0.043 | 0.550 |
| Below Median Lean Mass | 22 | 0.289     | 0.306 | 0.065 | 0.136 |
| Median Lean Mass       | 23 | 0.135     | 0.170 | 0.035 | 0.073 |
| Above Median Lean Mass | 7  | 0.181     | 0.322 | 0.122 | 0.298 |
| Below Median Fat Mass  | 39 | 0.240     | 0.285 | 0.046 | 0.092 |
### Median Fat Mass

| Below Median Fat Mass | Abundance | sd   | se  | ci    |
|-----------------------|-----------|------|-----|-------|
| 10                    | 0.087     | 0.125| 0.040| 0.090 |

### Above Median Fat Mass

| Above Median Fat Mass | Abundance | sd   | se  | ci    |
|-----------------------|-----------|------|-----|-------|
| 3                     | 0.176     | 0.196| 0.113| 0.487 |

### b. Streptococcus

| Body Condition                  | N  | Abundance | sd   | se  | ci    |
|---------------------------------|----|-----------|------|-----|-------|
| Below Median Body Fat           | 29 | 0.097     | 0.159| 0.029| 0.060 |
| Median Body Fat                 | 17 | 0.137     | 0.247| 0.060| 0.127 |
| Above Median Body Fat           | 6  | 0.175     | 0.236| 0.096| 0.248 |
| Below Median Net Mass           | 27 | 0.099     | 0.168| 0.032| 0.066 |
| Median Net Mass                 | 24 | 0.145     | 0.232| 0.047| 0.098 |
| Above Median Net Mass           | 2  | 0.026     | 0.022| 0.016| 0.197 |
| Below Median Lean Mass          | 22 | 0.114     | 0.181| 0.039| 0.080 |
| Median Lean Mass                | 23 | 0.151     | 0.236| 0.049| 0.102 |
| Above Median Lean Mass          | 7  | 0.031     | 0.031| 0.012| 0.029 |
| Below Median Fat Mass           | 39 | 0.106     | 0.186| 0.030| 0.060 |
| Median Fat Mass                 | 10 | 0.153     | 0.238| 0.075| 0.170 |
| Above Median Fat Mass           | 3  | 0.182     | 0.272| 0.157| 0.675 |

### c. Turicibacter

| Body Condition                  | N  | Abundance | sd   | se  | ci    |
|---------------------------------|----|-----------|------|-----|-------|
| Below Median Body Fat           | 29 | 0.166     | 0.237| 0.044| 0.090 |
| Median Body Fat                 | 17 | 0.106     | 0.151| 0.037| 0.078 |
| Above Median Body Fat           | 6  | 0.120     | 0.210| 0.086| 0.221 |
| Below Median Net Mass           | 27 | 0.141     | 0.216| 0.042| 0.085 |
| Median Net Mass                 | 24 | 0.126     | 0.190| 0.039| 0.080 |
| Above Median Net Mass           | 2  | 0.266     | 0.375| 0.265| 3.367 |
| Below Median Lean Mass          | 22 | 0.104     | 0.168| 0.036| 0.075 |
| Median Lean Mass                | 23 | 0.175     | 0.240| 0.050| 0.104 |
| Above Median Lean Mass          | 7  | 0.150     | 0.216| 0.082| 0.200 |
| Below Median Fat Mass           | 39 | 0.153     | 0.220| 0.035| 0.071 |
| Median Fat Mass                 | 10 | 0.864     | 0.121| 0.038| 0.086 |
| Above Median Fat Mass           | 3  | 0.178     | 0.306| 0.177| 0.760 |

### d. Clostridium sensu stricto 1

| Body Condition                  | N  | Abundance | sd   | se  | ci    |
|---------------------------------|----|-----------|------|-----|-------|
| Below Median Body Fat           | 29 | 0.082     | 0.134| 0.025| 0.051 |
| Median Body Fat                 | 17 | 0.102     | 0.174| 0.042| 0.089 |
| Above Median Body Fat           | 6  | 0.013     | 0.016| 0.006| 0.017 |
| Below Median Net Mass           | 27 | 0.089     | 0.151| 0.029| 0.060 |
| Median Net Mass                 | 24 | 0.073     | 0.135| 0.028| 0.057 |
| Above Median Net Mass           | 2  | 0.014     | 0.020| 0.014| 0.176 |
| Below Median Lean Mass          | 22 | 0.066     | 0.137| 0.029| 0.061 |
| Median Lean Mass                | 23 | 0.094     | 0.146| 0.030| 0.063 |
| Above Median Lean Mass          | 7  | 0.084     | 0.155| 0.059| 0.144 |
| Below Median Fat Mass           | 39 | 0.099     | 0.158| 0.025| 0.051 |
| Median Fat Mass                 | 10 | 0.028     | 0.040| 0.013| 0.028 |

### d. Helicobacter

| Body Condition                  | N  | Abundance | sd   | se  | ci    |
|---------------------------------|----|-----------|------|-----|-------|
Below Median Body Fat
Median Body Fat
Above Median Body Fat
Below Median Net Mass
Median Net Mass
Above Median Net Mass
Below Median Lean Mass
Median Lean Mass
Above Median Lean Mass
Below Median Fat Mass
Median Fat Mass
Above Median Fat Mass

Supplementary Table S6. One-way analysis of variance test for significant differences in brown bear (Ursus arctos) gut microbiome dominant genera abundance (≥10% mean abundance) between body metrics. No significant differences.

|                      | df | Sum Sq | Mean Sq | F value | Pr(>F) |
|----------------------|--|--|--------|--------|--------|--------|
| Body Fat             | 2 | 0.002 | 0.001  | 0.437  | 0.649  |
| Residuals            | 46| 0.107 | 0.002  |        |        |
| Net Mass             | 2 | 0.001 | 0.001  | 0.182  | 0.834  |
| Residuals            | 47| 0.110 | 0.002  |        |        |
| Lean Mass            | 2 | 0.005 | 0.003  | 1.134  | 0.331  |
| Residuals            | 46| 0.104 | 0.002  |        |        |
| Fat Mass             | 2 | 0.001 | 0.001  | 0.124  | 0.884  |
| Residuals            | 46| 0.109 | 0.002  |        |        |

Supplementary Table S7. Kruskal-Wallis rank sum test for significant differences in brown bear (Ursus arctos) gut microbiome dominant genera (≥10% mean abundance) between body metrics for non-parametric data. P-value adjusted with Bonferroni correction. No significant differences.

a. Escherichia-Shigella

|                      | K-W chi-squared | df | P value |
|----------------------|-----------------|----|---------|
| Body Fat             | 0.731           | 2  | 0.694   |
| Net Mass             | 1.997           | 2  | 0.368   |
| Lean Mass            | 2.084           | 2  | 0.353   |
| Fat Mass             | 1.779           | 2  | 0.411   |

b. Turicibacter

|                      | K-W chi-squared | df | P value |
|----------------------|-----------------|----|---------|
| Body Fat             | 0.678           | 2  | 0.712   |
| Net Mass             | 0.610           | 2  | 0.737   |
| Lean Mass            | 0.428           | 2  | 0.808   |
| Fat Mass             | 0.392           | 2  | 0.822   |
### c. *Clostridium sensu stricto 1*

|                  | K-W chi-squared | df | P value |
|------------------|-----------------|----|---------|
| Body Fat         | 1.361           | 2  | 0.506   |
| Net Mass         | 0.196           | 2  | 0.907   |
| Lean Mass        | 0.126           | 2  | 0.939   |
| Fat Mass         | 1.382           | 2  | 0.501   |

### d. *Helicobacter*

|                  | K-W chi-squared | df | P value |
|------------------|-----------------|----|---------|
| Body Fat         | 1.123           | 2  | 0.571   |
| Net Mass         | 3.649           | 2  | 0.161   |
| Lean Mass        | 2.863           | 2  | 0.239   |
| Fat Mass         | 1.335           | 2  | 0.513   |

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**Supplementary Table S8.** Alpha diversity values of brown bear (*Ursus arctos*) gut microbiomes.

#### a. Faith’s PD

| Body Condition               | N   | Diversity | sd  | se  | ci  |
|------------------------------|-----|-----------|-----|-----|-----|
| Below Median Body Fat        | 29  | 11.022    | 8.048| 1.494| 3.061|
| Median Body Fat              | 17  | 9.906     | 7.752| 1.880| 3.985|
| Above Median Body Fat        | 6   | 12.644    | 6.526| 2.664| 6.849|
| Below Median Net Mass        | 27  | 10.871    | 8.300| 1.597| 3.283|
| Median Net Mass              | 23  | 11.049    | 7.300| 1.522| 3.157|
| Above Median Net Mass        | 2   | 7.867     | 5.869| 4.150| 52.729|
| Below Median Lean Mass       | 22  | 11.649    | 8.776| 1.871| 3.891|
| Median Lean Mass             | 23  | 10.737    | 7.456| 1.555| 3.224|
| Above Median Lean Mass       | 7   | 8.593     | 4.589| 1.734| 4.244|
| Below Median Fat Mass        | 39  | 10.262    | 7.419| 1.188| 2.405|
| Median Fat Mass              | 10  | 13.843    | 9.228| 2.918| 6.601|
| Above Median Fat Mass        | 3   | 8.248     | 4.202| 2.426| 10.439|

#### b. Shannon diversity

| Body Condition               | N   | Diversity | sd  | se  | ci  |
|------------------------------|-----|-----------|-----|-----|-----|
| Below Median Body Fat        | 29  | 2.198     | 1.170| 0.217| 0.445|
| Median Body Fat              | 17  | 2.188     | 1.062| 0.258| 0.546|
| Above Median Body Fat        | 6   | 2.187     | 0.679| 0.277| 0.713|
| Below Median Net Mass        | 27  | 2.140     | 1.162| 0.224| 0.460|
| Median Net Mass              | 23  | 2.253     | 1.028| 0.214| 0.445|
| Above Median Net Mass        | 2   | 2.229     | 0.438| 0.310| 3.934|
| Below Median Lean Mass       | 22  | 2.116     | 1.228| 0.262| 0.544|
| Median Lean Mass             | 23  | 2.320     | 0.947| 0.198| 0.410|
| Above Median Lean Mass       | 7   | 2.019     | 1.049| 0.396| 0.970|
| Below Median Fat Mass        | 39  | 2.101     | 1.094| 0.175| 0.355|
| Median Fat Mass              | 10  | 2.636     | 1.052| 0.333| 0.752|
| Above Median Fat Mass        | 3   | 1.912     | 0.630| 0.364| 1.566|
Supplementary Table S9. One-way analysis of variance test for significant differences in brown bear (Ursus arctos) gut microbiome alpha diversity between body metrics. No significant differences.

**a. Faith’s PD**

| Body Condition       | df | Sum Sq  | Mean Sq | F value | Pr(>F) |
|----------------------|----|---------|---------|---------|---------|
| Body Fat             | 2  | 35.30   | 17.650  | 0.29    | 0.75    |
| Residuals            | 49 | 2987.70 | 60.970  |         |         |
| Net Mass             | 2  | 19.1    | 9.54    | 0.156   | 0.856   |
| Residuals            | 49 | 3003.9  | 61.30   |         |         |
| Lean Mass            | 2  | 64      | 32.23   | 0.235   | 0.792   |
| Residuals            | 49 | 6728    | 137.31  |         |         |
| Fat Mass             | 2  | 124.2   | 62.08   | 1.049   | 0.358   |
| Residuals            | 49 | 2898.9  | 59.16   |         |         |

**b. Shannon diversity**

| Body Condition       | df | Sum Sq  | Mean Sq | F value  | Pr(>F)  |
|----------------------|----|---------|---------|----------|---------|
| Body Fat             | 2  | 58.72   | 1.198   | 0.001    | 0.999   |
| Residuals            | 49 | 58.56   | 1.195   | 0.067    | 0.935   |
| Net Mass             | 2  | 0.16    | 0.080   | 0.067    | 0.935   |
| Residuals            | 49 | 58.01   | 1.1838  | 0.302    | 0.741   |
| Lean Mass            | 2  | 0.72    | 0.3578  | 0.302    | 0.741   |
| Residuals            | 49 | 2.53    | 1.263   | 1.101    | 0.341   |
| Fat Mass             | 2  | 2.53    | 1.263   | 1.101    | 0.341   |
| Residuals            | 49 | 56.20   | 1.147   |          |         |

**c. Inverse Simpson**

| Body Condition       | df | Sum Sq  | Mean Sq | F value  | Pr(>F)  |
|----------------------|----|---------|---------|----------|---------|
| Below Median Body Fat| 29 | 8.593   | 14.828  | 2.753    | 5.640   |
| Median Body Fat      | 17 | 6.203   | 5.428   | 1.316    | 2.791   |
| Above Median Body Fat| 6  | 5.080   | 3.659   | 1.494    | 3.840   |
| Below Median Net Mass| 27 | 8.443   | 15.431  | 2.970    | 6.104   |
| Median Net Mass      | 23 | 6.405   | 4.932   | 1.028    | 2.133   |
| Above Median Net Mass| 2  | 4.918   | 3.850   | 1.455    | 3.561   |
| Below Median Lean Mass| 22 | 8.525   | 16.903  | 3.604    | 7.494   |
| Median Lean Mass     | 23 | 6.847   | 5.433   | 1.133    | 2.349   |
| Above Median Lean Mass| 7  | 5.728   | 3.850   | 1.455    | 3.561   |
| Below Median Fat Mass| 39 | 7.470   | 12.968  | 2.076    | 4.204   |
| Median Fat Mass      | 10 | 8.139   | 6.316   | 1.997    | 4.518   |
| Above Median Fat Mass| 3  | 4.129   | 1.678   | 0.969    | 4.169   |
Supplementary Table S10. \(W^*_{d}\) test results for beta diversity indices comparing brown bears (Ursus arctos) with varying body conditions and their GMBs. Number of permutations was set to 9999 for all analysis.

### a. Weighted

| Body Condition | \(W^*_{d}\) stat | P value |
|----------------|------------------|---------|
| Body Fat       | 0.611            | 0.923   |
| Net Mass       | 0.911            | 0.329   |
| Lean Mass      | 1.300            | 0.135   |
| Fat Mass       | 0.611            | 0.923   |

### b. Unweighted

| Body Condition | \(W^*_{d}\) stat | P value |
|----------------|------------------|---------|
| Body Fat       | 0.955            | 0.446   |
| Net Mass       | 0.774            | 0.636   |
| Lean Mass      | 0.985            | 0.346   |
| Fat Mass       | 0.955            | 0.452   |

Supplementary Table S11. Microbial taxa significantly (p<0.05) enriched in gut microbiomes of brown bears (Ursus arctos) with varying health metrics, as determined by Linear discrimination analysis Effect Size analysis.

### a. % Body Fat

| Phylum          | Class          | Order          | Family          | Genus          | Log LDA |
|-----------------|----------------|----------------|-----------------|----------------|---------|
| **Median**      |                |                |                 |                |         |
| Cyanobacteria   | Melainabacteria|                |                 |                | 4.273   |
| **Above**       |                |                |                 |                |         |
| Firmicutes      | Clostridia     | Clostridiales  | Peptostreptococcaceae |               | 4.303   |

### b. Net Mass

| Phylum          | Class          | Order          | Family          | Genus          | Log LDA |
|-----------------|----------------|----------------|-----------------|----------------|---------|
| **Median**      |                |                |                 |                |         |
| Firmicutes      | Clostridia     | Clostridiales  | Clostridiaceae_1|               | 4.481   |
| Proteobacteria  | Gammaproteobacteria | Pasteurellales |                 |                | 4.379   |
### c. Lean Mass

| Phylum               | Class               | Order            | Family            | Genus               | Log LDA |
|----------------------|---------------------|------------------|-------------------|---------------------|---------|
| Actinobacteria       | Actinobacteria      | Propionibacteriales | Nocardoidaceae   | Nocardioides        | 3.866   |
| Firmicutes           | Clostridia          | Clostridiales    | Clostridaceae 1   | Clostridium         | 3.430   |
| **Median**           | **Actinobacteria**  | **Propionibacteriales** | **Nocardoidaceae** | **Nocardioides**   | **3.866** |
| **Firmicutes**       | **Clostridia**      | **Clostridiales** | **Clostridaceae 1** | **Clostridium**     | **3.430** |
| **Above**            | **Epsilonbacteraeota** | **Campylobacteria** | **Campylobacterales** | **Helicobacteraceae** | **4.751** |
| **Firmicutes**       | **Clostridia**      | **Clostridiales** | **Lachnospiraceae** | **Cellulosilyticum** | **3.915** |
| **d. Fat Mass**      | **Phylum**          | **Class**        | **Order**         | **Family**          | **Genus** | **Log LDA** |
| **Median**           | **Actinobacteria**  | **Micrococcales** | **Dermacoccaceae** |                     | 3.266   |
| **Acidobacteria**    | **Acidobacteriia**  | **Uncultured**   | **eubacterium**   | WD244               | 2.065   |
| **Chlamydiae**       | **Chlamydiae**      | **Chlamydiales** |                   |                     | 2.224   |
| **Chlamydiae**       | **Chlamydiae**      | **Chlamydiales** | **Parachlamydiaceae** | **Candidatus**     | 2.149   |
| **Dependentiae**     | **Babeliae**        |                   |                   |                     | 2.923   |
| **Dependentiae**     |                     |                   |                   |                     | 2.952   |
| **Firmicutes**       | **Clostridia**      | **Clostridiales** | **Peptococcaceae** |                     | 2.581   |
| **Firmicutes**       | **Bacilli**         | **Bacillales**   | **XI**            | **Gemella**         | 2.426   |
| **Firmicutes**       | **Bacilli**         | **Bacillales**   | **XI**            |                     | 2.445   |
| **Firmicutes**       | **Bacilli**         | **Lactobacillales** | **Streptococcaceae** | **Lactococcus**    | 2.027   |
| **Firmicutes**       | **Uncultured**      |                   |                   |                     | 2.223   |
| **Firmicutes**       | **Uncultured**      |                   |                   |                     | 2.159   |
| **Firmicutes**       | **Uncultured**      |                   |                   |                     | 2.085   |
| **Firmicutes**       | **Uncultured**      |                   |                   |                     | 2.174   |
| **Planctomycete**    |                     |                   |                   |                     | 2.072   |
| **Above**            | **Actinobacteria**  | **Coriobacteriia** | **Coriobacteriales** | **Atopibaceae**    | 2.645   |
| **Chloroflexi**      | **Ktedonobacteria** | **Ktedonobacterales** | **Ktedonobacteraceae** | **Olsenella**    | 2.155   |
**Supplementary Table S12.** Spearman’s non-parametric correlation analysis between a) major phyla (≥1% relative abundance) identified in brown bear (*Ursus arctos*) gut microbiomes and body condition measurements, b) dominant genera (≥10% mean abundance) and body condition measurements, and c) alpha diversity indices and body condition measurements.

### a. Major Phyla

| Phylum            | Body Metric       | S       | P value | Rho  |
|-------------------|-------------------|---------|---------|------|
| **Actinobacteria** | Body fat (%)      | 18291   | 0.649   | 0.067|
|                   | Net body mass (kg)| 20784   | 0.989   | 0.002|
|                   | Lean mass (kg)    | 19684   | 0.977   | -0.004|
|                   | Fat mass (kg)     | 18456   | 0.690   | 0.058|
| **Bacteroidetes** | Body fat (%)      | 20828   | 0.669   | -0.063|
|                   | Net body mass (kg)| 21687   | 0.775   | -0.041|
|                   | Lean mass (kg)    | 19899   | 0.917   | -0.015|
|                   | Fat mass (kg)     | 20527   | 0.747   | -0.047|
| **Epsilonbacteraeota** | Body fat (%) | 20908 | 0.649 | -0.067|
|                   | Net body mass (kg)| 25476   | 0.119   | -0.223|
|                   | Lean mass (kg)    | 22159   | 0.371   | -0.131|
|                   | Fat mass (kg)     | 21065   | 0.610   | -0.075|
| **Firmicutes**    | Body fat (%)      | 22476   | 0.775   | 0.041|
|                   | Net body mass (kg)| 23392   | 0.686   | 0.057|
|                   | Lean mass (kg)    | 21540   | 0.571   | 0.081|
|                   | Fat mass (kg)     | 21918   | 0.650   | 0.064|
| **Proteobacteria** | Body fat (%)      | 23341   | 0.980   | 0.004|
|                   | Net body mass (kg)| 26653   | 0.596   | -0.075|
|                   | Lean mass (kg)    | 26732   | 0.318   | -0.141|
|                   | Fat mass (kg)     | 24932   | 0.651   | -0.064|
| **Tenericutes**   | Body fat (%)      | 2398    | 0.843   | -0.043|
|                   | Net body mass (kg)| 2544    | 0.919   | 0.022|
|                   | Lean mass (kg)    | 2111    | 0.702   | 0.082|
|                   | Fat mass (kg)     | 2279    | 0.966   | -0.009|

### b. Dominant Genera

| Genus             | Body Metric       | S       | P value | Rho  |
|-------------------|-------------------|---------|---------|------|
| **Escherichia-Shigella** | Body fat (%)      | 24756   | 0.689   | -0.057|
|                   | Net body mass (kg)| 29172   | 0.207   | -0.176|
|                   | Lean mass (kg)    | 27841   | 0.181   | -0.188|
|                   | Fat mass (kg)     | 26575   | 0.342   | -0.134|
| **Streptococcus** | Body fat (%)      | 16977   | 0.359   | 0.134|
|                   | Net body mass (kg)| 20781   | 0.988   | 0.002|
|                   | Lean mass (kg)    | 20729   | 0.694   | -0.058|
|                   | Fat mass (kg)     | 17166   | 0.395   | 0.124|
| Diversity Index | Body Metric     | S       | P value | Rho     |
|-----------------|-----------------|---------|---------|---------|
| Faith’s PD      | Body fat (%)    | 21977   | 0.662   | 0.062   |
|                 | Net body mass (kg) | 22547   | 0.7917  | 0.038   |
|                 | Lean mass (kg)   | 22702   | 0.828   | 0.031   |
|                 | Fat mass (kg)    | 21409   | 0.544   | 0.086   |
| Shannon         | Body fat (%)    | 21187   | 0.500   | 0.096   |
|                 | Net body mass (kg) | 20245   | 0.337   | 0.136   |
|                 | Lean mass (kg)   | 19458   | 0.230   | 0.169   |
|                 | Fat mass (kg)    | 19631   | 0.251   | 0.162   |
| Inverse Simpson’s | Body fat (%)   | 22467   | 0.773   | 0.041   |
|                 | Net body mass (kg) | 19686   | 0.258   | 0.160   |
|                 | Lean mass (kg)   | 18714   | 0.153   | 0.201   |
|                 | Fat mass (kg)    | 20242   | 0.337   | 0.136   |
**Supplementary Table S13.** Metadata for each brown bear (*Ursus arctos*) sampled during 2015-2017 National Park Service research activities.

| Sample ID | ASVs   | Initial diversity (non-normalized) | Retained diversity (normalized) | % Retained diversity (normalized) | Body Fat (%) | Net Body Mass (kg) | Lean Mass (kg) | Fat Mass (kg) |
|-----------|--------|-----------------------------------|--------------------------------|----------------------------------|--------------|-------------------|----------------|--------------|
| G14006    | 22339  | 219                               | 216                            | 98.630                           | 13.530       | 76.854            | 87.252         | 10.398       |
| G14011    | 31490  | 185                               | 173                            | 93.514                           | 6.951        | 84.991            | 79.083         | 5.908        |
| G14020    | 49920  | 124                               | 99                             | 79.839                           | 12.683       | 98.101            | 85.659         | 12.442       |
| G14026    | 39502  | 44                                | 39                             | 88.636                           | 4.673        | 86.799            | 82.743         | 4.056        |
| G14030    | 35343  | 24                                | 22                             | 91.667                           | 4.155        | 94.937            | 90.992         | 3.944        |
| G14032    | 28538  | 108                               | 107                            | 99.074                           | 7.532        | 79.11             | 73.155         | 5.959        |
| G15001    | 33444  | 56                                | 50                             | 89.286                           | 3.000        | 132.459           | 129.993        | 2.467        |
| G15003    | 31898  | 74                                | 69                             | 93.243                           | 3.000        | 79.566            | 78.523         | 1.043        |
| G15006    | 8319   | 27                                | 27                             | 100                              | 11.160       | 81.826            | 72.695         | 9.132        |
| G15009    | 29794  | 34                                | 32                             | 94.118                           | 8.701        | 89.060            | 81.310         | 7.749        |
| G16001    | 24938  | 53                                | 50                             | 94.34                           | 17.154       | 94.937            | 78.651         | 16.286       |
| G16003    | 47613  | 39                                | 32                             | 82.051                           | 13.839       | 90.416            | 77.903         | 12.513       |
| G16005    | 30105  | 41                                | 36                             | 87.805                           | 3.000        | 133.363           | 131.221        | 2.1429       |
| G16008    | 12580  | 37                                | 37                             | 100                              | 15.332       | 100.814           | 85.357         | 15.457       |
| G16009    | 38494  | 141                               | 122                            | 86.525                           | 33.735       | 247.740           | 164.164        | 83.575       |
| K106      | 27281  | 58                                | 48                             | 82.759                           | 14.8         | 180.800           | 154.100        | 26.700       |
| K116      | 28691  | 156                               | 141                            | 90.385                           | 12.000       | 145.100           | 127.700        | 17.400       |
| K117      | 36917  | 62                                | 59                             | 95.161                           | 9.200        | 157.800           | 143.200        | 14.500       |
| K16A1     | 47070  | 101                               | 94                             | 93.069                           | 11.400       | 87.300            | 77.300         | 9.900        |
| K16A2     | 19156  | 275                               | 267                            | 97.091                           | 3.600        | 100.800           | 97.100         | 3.700        |
| K16A3     | 13014  | 215                               | 215                            | 100                              | 32.300       | 142.400           | 96.400         | 46.100       |
| K37       | 23158  | 108                               | 106                            | 98.148                           | 22.200       | 179.000           | 139.200        | 39.800       |
| K46       | 27338  | 186                               | 150                            | 80.645                           | 17.000       | 220.200           | 182.700        | 37.500       |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K55 | 50743 | 53 | 44 | 83.019 | 16.900 | 150.100 | 124.800 | 25.300 |
| K56A1 | 68370 | 73 | 59 | 80.822 | 24.600 | 197.600 | 149.000 | 48.500 |
| K56A2 | 14684 | 77 | 77 | 100 | 18.400 | 220.600 | 179.900 | 40.700 |
| K56A3 | 19635 | 28 | 28 | 100 | 37.300 | 302.900 | 190.000 | 112.900 |
| K57B1 | 16611 | 82 | 82 | 100 | 17.500 | 117.100 | 96.600 | 20.500 |
| K57B2 | 46593 | 104 | 80 | 76.923 | 6.800 | 161.400 | 150.400 | 11.000 |
| K57B3 | 43852 | 51 | 47 | 92.157 | 20.700 | 167.700 | 133.000 | 34.700 |
| K66 | 33904 | 328 | 323 | 98.476 | 8.500 | 124.300 | 113.700 | 10.600 |
| K67 | Dropped | | | 5.100 | 169.500 | 161.000 | 8.600 |
| K76A1 | 51412 | 375 | 320 | 85.333 | 14.700 | 157.800 | 134.600 | 23.200 |
| K76A2 | 17191 | 101 | 99 | 98.020 | 14.900 | 170.000 | 144.600 | 25.300 |
| K76A3 | 51655 | 101 | 63 | 62.376 | 39.000 | 214.300 | 130.800 | 83.500 |
| K76B1 | 52626 | 92 | 67 | 72.826 | 7.900 | 146.900 | 135.400 | 11.500 |
| K76B2 | 59738 | 50 | 40 | 80 | 21.700 | 188.500 | 147.700 | 40.800 |
| K86 | Dropped | | | 15.100 | 172.200 | 146.300 | 25.900 |
| K87B1 | 40277 | 55 | 49 | 89.091 | 18.700 | 119.800 | 97.400 | 22.400 |
| K87B2 | 4087 | 180 | 180 | 100 | 25.100 | 154.200 | 115.500 | 38.700 |
| K95A2 | 23082 | 32 | 29 | 90.625 | 3.000 | 202.100 | 198.600 | 3.500 |
| K96 | 50225 | 98 | 88 | 89.796 | 22.500 | 222.400 | 172.000 | 50.000 |
| K97B1 | 35732 | 534 | 526 | 98.502 | 8.600 | 120.300 | 109.900 | 10.400 |
| K97B2 | 13660 | 124 | 124 | 100 | 20.600 | 168.200 | 133.500 | 34.700 |
| K97B3 | 63873 | 211 | 157 | 74.408 | 31.700 | 172.200 | 117.700 | 54.600 |
| L401 | 26880 | 107 | 87 | 81.308 | 9.355 | 160.940 | 145.884 | 15.056 |
| L405 | 65660 | 76 | 52 | 68.421 | 13.817 | 98.101 | 84.547 | 13.555 |
| L412 | 49341 | 47 | 27 | 57.447 | 10.542 | 121.157 | 108.385 | 12.773 |
| L415 | 7241 | 58 | 58 | 100 | 8.657 | 165.913 | 151.550 | 14.364 |
| L421A | 57236 | 56 | 33 | 58.929 | 13.192 | 198.463 | 172.282 | 26.181 |
| L423 | 51326 | 55 | 31 | 56.364 | 19.674 | 96.745 | 77.7118 | 19.033 |
| L521 | 14106 | 378 | 377 | 99.735 | 22.953 | 192.586 | 148.382 | 44.204 |
| Code | Value 1 | Value 2 | Value 3 | Value 4 | Value 5 | Value 6 | Value 7 | Value 8 |
|------|---------|---------|---------|---------|---------|---------|---------|---------|
| L522 | 46327   | 210     | 171     | 81.429  | 27.142  | 165.009 | 120.28  | 44.787  |
| L601 | 60402   | 72      | 41      | 56.944  | 21.728  | 155.967 | 122.079 | 33.888  |