```
a =
  Import["C:\\Users\\loubar\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
     Odonata code\\M_params\\Hui\\pres10km.csv"];
d1 = Dimensions[a][[1]]; d2 = Dimensions[a][[2]]; unit = 10 000;
(*unit is the linear resolution in m, in this case 10000m*)
```

```
d1
```

2290

```
d2
```

43

```
spp = {"Enallagma_cyathigerum", "Sympetrum_sanguineum",
   "Sympetrum_striolatum", "Pyrrhosoma_nymphula", "Brachytron_pratense",
   "Aeshna_cyanea", "Libellula_depressa", "Anax_imperator",
   "Aeshna_grandis", "Libellula_quadrimaculata", "Coenagrion_puella",
   "Erythromma_najas", "Calopteryx_splendens", "Cordulegaster_boltonii",
   "Aeshna_juncea", "Gomphus_vulgatissimus", "Orthetrum_cancellatum",
   "Lestes_sponsa", "Platycnemis_pennipes", "Aeshna_mixta",
   "Ischnura_elegans", "Coenagrion_mercuriale", "Ceriagrion_tenellum",
   "Orthetrum_coerulescens", "Leucorrhinia_dubia", "Ischnura_pumilio",
   "Sympetrum_fonscolombii", "Cordulia_aenea", "Calopteryx_virgo",
   "Libellula_fulva", "Sympetrum_danae", "Erythromma_viridulum",
   "Somatochlora_arctica", "Coenagrion_pulchellum", "Somatochlora_metallica",
   "Aeshna_caerulea", "Lestes_dryas", "Aeshna_isosceles",
   "Coenagrion_hastulatum", "Sympetrum_flaveolum", "Anax_parthenope"};
(* 1
 x1
 km
 grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
       Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 10;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       here, we are calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* n = 5/2 is better than n = 2.5 for accuracy *)
```

$$\text{z = FindRoot}\Big[\text{p0}\left(\text{p0}^{-\frac{1}{-1+n}}\,\text{p100}^{\frac{1}{-1+n}}\,\text{q100}^{-1/n}\right)^{2(-1+n)}\left(\frac{\text{p0}^{1-\frac{2}{-1+n}}\,\text{p100}^{\frac{2}{-1+n}}\,\text{q100}^{-2/n}}{\text{p0}^{1-\frac{2}{-1+n}}\,\text{p100}^{\frac{2}{-1+n}}\,\text{q100}^{-2/n}+\frac{\text{p0}^{2}\left(1-\text{p0}^{-\frac{1}{-1+n}}\,\text{p100}^{\frac{1}{-1+n}}\,\text{q100}^{-1/n}\right)^{2}}{1-\text{p0}}}\right)^{(-1+n)^{2}} ==$$

```
       p100, {p0, (p100 + 1) / 2}][[1, 2]];
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p₊(", unit, "x",
    unit, ")=", p[j - 2], "; q₊/₊(", unit, "x", unit, ")=", q[j - 2],
    "; the estimated p₊(", unit / n, "x", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

```
Species 1: p₊(10 000×10 000)=0.809524; q₊/₊(10 000
 ×10 000)=0.862347; the estimated p₊(1000×1000)=0.352389

Species 2: p₊(10 000×10 000)=0.387942; q₊/₊(10 000
 ×10 000)=0.788527; the estimated p₊(1000×1000)=0.231864
```

Species 3: $p_+(10\,000\times10\,000)=0.760157$; $q_{+/+}(10\,000\times10\,000)=0.860525$; the estimated $p_+(1000\times1000)=0.423926$

Species 4: $p_+(10\,000\times10\,000)=0.819572$; $q_{+/+}(10\,000\times10\,000)=0.870532$; the estimated $p_+(1000\times1000)=0.373341$

Species 5: $p_+(10\,000\times10\,000)=0.188729$; $q_{+/+}(10\,000\times10\,000)=0.668632$; the estimated $p_+(1000\times1000)=0.0853866$

Species 6: $p_+(10\,000\times10\,000)=0.579292$; $q_{+/+}(10\,000\times10\,000)=0.85079$; the estimated $p_+(1000\times1000)=0.390246$

Species 7: $p_+(10\,000\times10\,000)=0.49716$; $q_{+/+}(10\,000\times10\,000)=0.840835$; the estimated $p_+(1000\times1000)=0.336235$

Species 8: $p_+(10\,000\times10\,000)=0.51682$; $q_{+/+}(10\,000\times10\,000)=0.847151$; the estimated $p_+(1000\times1000)=0.354097$

Species 9: $p_+(10\,000\times10\,000)=0.400612$; $q_{+/+}(10\,000\times10\,000)=0.866556$; the estimated $p_+(1000\times1000)=0.299441$

Species 10: $p_+(10\,000\times10\,000)=0.632591$; $q_{+/+}(10\,000\times10\,000)=0.76601$; the estimated $p_+(1000\times1000)=0.244985$

Species 11: $p_+(10\,000\times10\,000)=0.623416$; $q_{+/+}(10\,000\times10\,000)=0.857592$; the estimated $p_+(1000\times1000)=0.41958$

Species 12: $p_+(10\,000\times10\,000)=0.26955$; $q_{+/+}(10\,000\times10\,000)=0.789825$; the estimated $p_+(1000\times1000)=0.168669$

Species 13: $p_+(10\,000\times10\,000)=0.455221$; $q_{+/+}(10\,000\times10\,000)=0.807251$; the estimated $p_+(1000\times1000)=0.280321$

Species 14: $p_+(10\,000\times10\,000)=0.414592$; $q_{+/+}(10\,000\times10\,000)=0.768369$; the estimated $p_+(1000\times1000)=0.227933$

Species 15: $p_+(10\,000\times10\,000)=0.536916$; $q_{+/+}(10\,000\times10\,000)=0.749098$; the estimated $p_+(1000\times1000)=0.236763$

Species 16: $p_+(10\,000\times10\,000)=0.041066$; $q_{+/+}(10\,000\times10\,000)=0.554078$; the estimated $p_+(1000\times1000)=0.0142899$

Species 17: $p_+(10\,000\times10\,000)=0.408038$; $q_{+/+}(10\,000\times10\,000)=0.787138$; the estimated $p_+(1000\times1000)=0.24041$

Species 18: $p_+(10\,000\times10\,000)=0.644823$; $q_{+/+}(10\,000\times10\,000)=0.742461$; the estimated $p_+(1000\times1000)=0.186606$

Species 19: $p_+(10\,000\times10\,000)=0.155526$; $q_{+/+}(10\,000\times10\,000)=0.70033$; the estimated $p_+(1000\times1000)=0.0787431$

Species 20: $p_+(10\,000\times10\,000)=0.457842$; $q_{+/+}(10\,000\times10\,000)=0.839762$; the estimated $p_+(1000\times1000)=0.312992$

Species 21: $p_+(10\,000\times10\,000)=0.766273$; $q_{+/+}(10\,000\times10\,000)=0.857524$; the estimated $p_+(1000\times1000)=0.406879$

Species 22: $p_+(10\,000\times10\,000)=0.0144168$; $q_{+/+}(10\,000\times10\,000)=0.462121$; the estimated $p_+(1000\times1000)=0.00377523$

Species 23: $p_+(10\,000\times10\,000)=0.0449978$; $q_{+/+}(10\,000\times10\,000)=0.50817$; the estimated $p_+(1000\times1000)=0.0134027$

Species 24: $p_+(10\,000\times10\,000)=0.131498$; $q_{+/+}(10\,000\times10\,000)=0.562287$; the estimated $p_+(1000\times1000)=0.043441$

Species 25: $p_+(10\,000\times10\,000)=0.0222805$; $q_{+/+}(10\,000\times10\,000)=0.367647$; the estimated $p_+(1000\times1000)=0.00396936$

Species 26: $p_+(10\,000\times10\,000)=0.0624727$; $q_{+/+}(10\,000\times10\,000)=0.46256$; the estimated $p_+(1000\times1000)=0.0154197$

Species 27: $p_+(10\,000\times10\,000)=0.100481$; $q_{+/+}(10\,000\times10\,000)=0.25372$; the estimated $p_+(1000\times1000)=0.0071381$

Species 28: $p_+(10\,000\times10\,000)=0.0755789$; $q_{+/+}(10\,000\times10\,000)=0.585283$; the estimated $p_+(1000\times1000)=0.0282977$

Species 29: $p_+(10\,000\times10\,000)=0.273482$; $q_{+/+}(10\,000\times10\,000)=0.748106$; the estimated $p_+(1000\times1000)=0.151555$

Species 30: $p_+(10\,000\times10\,000)=0.0624727$; $q_{+/+}(10\,000\times10\,000)=0.446009$; the estimated $p_+(1000\times1000)=0.0144412$

Species 31: $p_+(10\,000\times10\,000)=0.390127$; $q_{+/+}(10\,000\times10\,000)=0.609041$; the estimated $p_+(1000\times1000)=0.104897$

Species 32: $p_+(10\,000\times10\,000)=0.140673$; $q_{+/+}(10\,000\times10\,000)=0.603583$; the estimated $p_+(1000\times1000)=0.053213$

Species 33: $p_+(10\,000\times10\,000)=0.0336391$; $q_{+/+}(10\,000\times10\,000)=0.422149$; the estimated $p_+(1000\times1000)=0.00738263$

Species 34: $p_+(10\,000\times10\,000)=0.0764526$; $q_{+/+}(10\,000\times10\,000)=0.380329$; the estimated $p_+(1000\times1000)=0.0128829$

Species 35: $p_+(10\,000\times10\,000)=0.024028$; $q_{+/+}(10\,000\times10\,000)=0.566358$; the estimated $p_+(1000\times1000)=0.0087938$

Species 36: $p_+(10\,000\times10\,000)=0.0332023$; $q_{+/+}(10\,000\times10\,000)=0.463816$; the estimated $p_+(1000\times1000)=0.0085542$

Species 37: $p_+(10\,000\times10\,000)=0.0244648$; $q_{+/+}(10\,000\times10\,000)=0.523148$; the estimated $p_+(1000\times1000)=0.00781141$

Species 38: $p_+(10\,000\times10\,000)=0.0144168$; $q_{+/+}(10\,000\times10\,000)=0.669192$; the estimated $p_+(1000\times1000)=0.00707567$

Species 39: $p_+(10\,000\times10\,000)=0.00655308$; $q_{+/+}(10\,000\times10\,000)=0.3$; the estimated $p_+(1000\times1000)=0.00088244$

Species 40: $p_+(10\,000\times10\,000)=0.08519$; $q_{+/+}(10\,000\times10\,000)=0.295614$; the estimated $p_+(1000\times1000)=0.00874274$

Species 41: $p_+(10\,000\times10\,000)=0.0506772$; $q_{+/+}(10\,000\times10\,000)=0.189732$; the estimated $p_+(1000\times1000)=0.00286189$

```
Export["C:\\Users\\loubar\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_1km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_1km.dat
```

```
(* 2x2 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
      Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 5;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
```

$$z = \text{FindRoot}\Big[p0\left(p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2(-1+n)} \Bigg(\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}\right) \Big/ \left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n} + \frac{p0^{2}\left(1-p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2}}{1-p0}\right)\Bigg)^{(-1+n)^{2}} == p100,\ \{p0,\ (p100+1)/2\}\Big][[1, 2]];$$

```
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p+(", unit, "×",
    unit, ")=", p[j - 2], "; q+/+(", unit, "×", unit, ")=", q[j - 2],
    "; the estimated p+(", unit / n, "×", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

```
Species 1: p+(10 000×10 000)=0.809524; q+/+(10 000
 ×10 000)=0.862347; the estimated p+(2000×2000)=0.412449
```

Species 2: $p_+(10\,000\times10\,000)=0.387942$; $q_{+/+}(10\,000\times10\,000)=0.788527$; the estimated $p_+(2000\times2000)=0.248536$

Species 3: $p_+(10\,000\times10\,000)=0.760157$; $q_{+/+}(10\,000\times10\,000)=0.860525$; the estimated $p_+(2000\times2000)=0.467231$

Species 4: $p_+(10\,000\times10\,000)=0.819572$; $q_{+/+}(10\,000\times10\,000)=0.870532$; the estimated $p_+(2000\times2000)=0.433127$

Species 5: $p_+(10\,000\times10\,000)=0.188729$; $q_{+/+}(10\,000\times10\,000)=0.668632$; the estimated $p_+(2000\times2000)=0.0952674$

Species 6: $p_+(10\,000\times10\,000)=0.579292$; $q_{+/+}(10\,000\times10\,000)=0.85079$; the estimated $p_+(2000\times2000)=0.412185$

Species 7: $p_+(10\,000\times10\,000)=0.49716$; $q_{+/+}(10\,000\times10\,000)=0.840835$; the estimated $p_+(2000\times2000)=0.354327$

Species 8: $p_+(10\,000\times10\,000)=0.51682$; $q_{+/+}(10\,000\times10\,000)=0.847151$; the estimated $p_+(2000\times2000)=0.372539$

Species 9: $p_+(10\,000\times10\,000)=0.400612$; $q_{+/+}(10\,000\times10\,000)=0.866556$; the estimated $p_+(2000\times2000)=0.31061$

Species 10: $p_+(10\,000\times10\,000)=0.632591$; $q_{+/+}(10\,000\times10\,000)=0.76601$; the estimated $p_+(2000\times2000)=0.287774$

Species 11: $p_+(10\,000\times10\,000)=0.623416$; $q_{+/+}(10\,000\times10\,000)=0.857592$; the estimated $p_+(2000\times2000)=0.443735$

Species 12: $p_+(10\,000\times10\,000)=0.26955$; $q_{+/+}(10\,000\times10\,000)=0.789825$; the estimated $p_+(2000\times2000)=0.179204$

Species 13: $p_+(10\,000\times10\,000)=0.455221$; $q_{+/+}(10\,000\times10\,000)=0.807251$; the estimated $p_+(2000\times2000)=0.299493$

Species 14: $p_+(10\,000\times10\,000)=0.414592$; $q_{+/+}(10\,000\times10\,000)=0.768369$; the estimated $p_+(2000\times2000)=0.24776$

Species 15: $p_+(10\,000\times10\,000)=0.536916$; $q_{+/+}(10\,000\times10\,000)=0.749098$; the estimated $p_+(2000\times2000)=0.268967$

Species 16: $p_+(10\,000\times10\,000)=0.041066$; $q_{+/+}(10\,000\times10\,000)=0.554078$; the estimated $p_+(2000\times2000)=0.0166039$

Species 17: $p_+(10\,000\times10\,000)=0.408038$; $q_{+/+}(10\,000\times10\,000)=0.787138$; the estimated $p_+(2000\times2000)=0.258384$

Species 18: $p_+(10\,000\times10\,000)=0.644823$; $q_{+/+}(10\,000\times10\,000)=0.742461$; the estimated $p_+(2000\times2000)=0.23453$

Species 19: $p_+(10\,000\times10\,000)=0.155526$; $q_{+/+}(10\,000\times10\,000)=0.70033$; the estimated $p_+(2000\times2000)=0.0862209$

Species 20: $p_+(10\,000\times10\,000)=0.457842$; $q_{+/+}(10\,000\times10\,000)=0.839762$; the estimated $p_+(2000\times2000)=0.329087$

Species 21: $p_+(10\,000\times10\,000)=0.766273$; $q_{+/+}(10\,000\times10\,000)=0.857524$; the estimated $p_+(2000\times2000)=0.453202$

Species 22: $p_+(10\,000\times10\,000)=0.0144168$; $q_{+/+}(10\,000\times10\,000)=0.462121$; the estimated $p_+(2000\times2000)=0.00462109$

Species 23: $p_+(10\,000\times10\,000)=0.0449978$; $q_{+/+}(10\,000\times10\,000)=0.50817$; the estimated $p_+(2000\times2000)=0.0160239$

Species 24: $p_+(10\,000\times10\,000)=0.131498$; $q_{+/+}(10\,000\times10\,000)=0.562287$; the estimated $p_+(2000\times2000)=0.0511154$

Species 25: $p_+(10\,000\times10\,000)=0.0222805$; $q_{+/+}(10\,000\times10\,000)=0.367647$; the estimated $p_+(2000\times2000)=0.00527664$

Species 26: $p_+(10\,000\times10\,000)=0.0624727$; $q_{+/+}(10\,000\times10\,000)=0.46256$; the estimated $p_+(2000\times2000)=0.0191436$

Species 27: p_+(10 000×10 000)=0.100481; $q_{+/+}$(10 000 ×10 000)=0.25372; the estimated p_+(2000×2000)=0.0123301

Species 28: p_+(10 000×10 000)=0.0755789; $q_{+/+}$(10 000 ×10 000)=0.585283; the estimated p_+(2000×2000)=0.0324961

Species 29: p_+(10 000×10 000)=0.273482; $q_{+/+}$(10 000 ×10 000)=0.748106; the estimated p_+(2000×2000)=0.164004

Species 30: p_+(10 000×10 000)=0.0624727; $q_{+/+}$(10 000 ×10 000)=0.446009; the estimated p_+(2000×2000)=0.0181737

Species 31: p_+(10 000×10 000)=0.390127; $q_{+/+}$(10 000 ×10 000)=0.609041; the estimated p_+(2000×2000)=0.130561

Species 32: p_+(10 000×10 000)=0.140673; $q_{+/+}$(10 000 ×10 000)=0.603583; the estimated p_+(2000×2000)=0.0611227

Species 33: p_+(10 000×10 000)=0.0336391; $q_{+/+}$(10 000 ×10 000)=0.422149; the estimated p_+(2000×2000)=0.00937837

Species 34: p_+(10 000×10 000)=0.0764526; $q_{+/+}$(10 000 ×10 000)=0.380329; the estimated p_+(2000×2000)=0.0174164

Species 35: p_+(10 000×10 000)=0.024028; $q_{+/+}$(10 000 ×10 000)=0.566358; the estimated p_+(2000×2000)=0.010123

Species 36: p_+(10 000×10 000)=0.0332023; $q_{+/+}$(10 000 ×10 000)=0.463816; the estimated p_+(2000×2000)=0.0105136

Species 37: p_+(10 000×10 000)=0.0244648; $q_{+/+}$(10 000 ×10 000)=0.523148; the estimated p_+(2000×2000)=0.00921246

Species 38: p_+(10 000×10 000)=0.0144168; $q_{+/+}$(10 000 ×10 000)=0.669192; the estimated p_+(2000×2000)=0.00776548

Species 39: p_+(10 000×10 000)=0.00655308; $q_{+/+}$(10 000×10 000)=0.3; the estimated p_+(2000×2000)=0.00125381

Species 40: p_+(10 000×10 000)=0.08519; $q_{+/+}$(10 000 ×10 000)=0.295614; the estimated p_+(2000×2000)=0.0134681

Species 41: p_+(10 000×10 000)=0.0506772; $q_{+/+}$(10 000 ×10 000)=0.189732; the estimated p_+(2000×2000)=0.00530375

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_2km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
 (*You can export the results into a dat file that can be read
 by Excel. Remember to change the path and you file name*)
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_2km.dat
```

```
(* 5x5 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
       Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 2;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
```

$$z = \text{FindRoot}\left[\text{p0}\left(\text{p0}^{-\frac{1}{-1+n}}\,\text{p100}^{\frac{1}{-1+n}}\,\text{q100}^{-1/n}\right)^{2\,(-1+n)}\left(\left(\text{p0}^{1-\frac{2}{-1+n}}\,\text{p100}^{\frac{2}{-1+n}}\,\text{q100}^{-2/n}\right)\middle/\left(\text{p0}^{1-\frac{2}{-1+n}}\,\text{p100}^{\frac{2}{-1+n}}\,\text{q100}^{-2/n}+\frac{\text{p0}^2\left(1-\text{p0}^{-\frac{1}{-1+n}}\,\text{p100}^{\frac{1}{-1+n}}\,\text{q100}^{-1/n}\right)^2}{1-\text{p0}}\right)\right)^{(-1+n)^2} == \text{p100},\ \{\text{p0},\ (\text{p100}+1)/2\}\right][[1,2]];$$

```
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p+(", unit, "×",
    unit, ")=", p[j - 2], "; q+/+(", unit, "×", unit, ")=", q[j - 2],
    "; the estimated p+(", unit / n, "×", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

```
Species 1: p+(10 000×10 000)=0.809524; q+/+(10 000
 ×10 000)=0.862347; the estimated p+(5000×5000)=0.586871
```

Species 2: $p_+(10\,000\times10\,000)=0.387942$; $q_{+/+}(10\,000\times10\,000)=0.788527$; the estimated $p_+(5000\times5000)=0.299966$

Species 3: $p_+(10\,000\times10\,000)=0.760157$; $q_{+/+}(10\,000\times10\,000)=0.860525$; the estimated $p_+(5000\times5000)=0.591216$

Species 4: $p_+(10\,000\times10\,000)=0.819572$; $q_{+/+}(10\,000\times10\,000)=0.870532$; the estimated $p_+(5000\times5000)=0.604645$

Species 5: $p_+(10\,000\times10\,000)=0.188729$; $q_{+/+}(10\,000\times10\,000)=0.668632$; the estimated $p_+(5000\times5000)=0.127528$

Species 6: $p_+(10\,000\times10\,000)=0.579292$; $q_{+/+}(10\,000\times10\,000)=0.85079$; the estimated $p_+(5000\times5000)=0.477159$

Species 7: $p_+(10\,000\times10\,000)=0.49716$; $q_{+/+}(10\,000\times10\,000)=0.840835$; the estimated $p_+(5000\times5000)=0.408661$

Species 8: $p_+(10\,000\times10\,000)=0.51682$; $q_{+/+}(10\,000\times10\,000)=0.847151$; the estimated $p_+(5000\times5000)=0.427699$

Species 9: $p_+(10\,000\times10\,000)=0.400612$; $q_{+/+}(10\,000\times10\,000)=0.866556$; the estimated $p_+(5000\times5000)=0.344332$

Species 10: $p_+(10\,000\times10\,000)=0.632591$; $q_{+/+}(10\,000\times10\,000)=0.76601$; the estimated $p_+(5000\times5000)=0.421752$

Species 11: $p_+(10\,000\times10\,000)=0.623416$; $q_{+/+}(10\,000\times10\,000)=0.857592$; the estimated $p_+(5000\times5000)=0.514612$

Species 12: $p_+(10\,000\times10\,000)=0.26955$; $q_{+/+}(10\,000\times10\,000)=0.789825$; the estimated $p_+(5000\times5000)=0.211964$

Species 13: $p_+(10\,000\times10\,000)=0.455221$; $q_{+/+}(10\,000\times10\,000)=0.807251$; the estimated $p_+(5000\times5000)=0.357918$

Species 14: $p_+(10\,000\times10\,000)=0.414592$; $q_{+/+}(10\,000\times10\,000)=0.768369$; the estimated $p_+(5000\times5000)=0.309287$

Species 15: $p_+(10\,000\times10\,000)=0.536916$; $q_{+/+}(10\,000\times10\,000)=0.749098$; the estimated $p_+(5000\times5000)=0.369811$

Species 16: $p_+(10\,000\times10\,000)=0.041066$; $q_{+/+}(10\,000\times10\,000)=0.554078$; the estimated $p_+(5000\times5000)=0.0245538$

Species 17: $p_+(10\,000\times10\,000)=0.408038$; $q_{+/+}(10\,000\times10\,000)=0.787138$; the estimated $p_+(5000\times5000)=0.313775$

Species 18: $p_+(10\,000\times10\,000)=0.644823$; $q_{+/+}(10\,000\times10\,000)=0.742461$; the estimated $p_+(5000\times5000)=0.391755$

Species 19: $p_+(10\,000\times10\,000)=0.155526$; $q_{+/+}(10\,000\times10\,000)=0.70033$; the estimated $p_+(5000\times5000)=0.110338$

Species 20: $p_+(10\,000\times10\,000)=0.457842$; $q_{+/+}(10\,000\times10\,000)=0.839762$; the estimated $p_+(5000\times5000)=0.377658$

Species 21: $p_+(10\,000\times10\,000)=0.766273$; $q_{+/+}(10\,000\times10\,000)=0.857524$; the estimated $p_+(5000\times5000)=0.586303$

Species 22: $p_+(10\,000\times10\,000)=0.0144168$; $q_{+/+}(10\,000\times10\,000)=0.462121$; the estimated $p_+(5000\times5000)=0.00766645$

Species 23: $p_+(10\,000\times10\,000)=0.0449978$; $q_{+/+}(10\,000\times10\,000)=0.50817$; the estimated $p_+(5000\times5000)=0.0252466$

Species 24: $p_+(10\,000\times10\,000)=0.131498$; $q_{+/+}(10\,000\times10\,000)=0.562287$; the estimated $p_+(5000\times5000)=0.0774958$

Species 25: $p_+(10\,000\times10\,000)=0.0222805$; $q_{+/+}(10\,000\times10\,000)=0.367647$; the estimated $p_+(5000\times5000)=0.0103$

Species 26: $p_+(10\,000\times10\,000)=0.0624727$; $q_{+/+}(10\,000\times10\,000)=0.46256$; the estimated $p_+(5000\times5000)=0.0326337$

```
Species 27: p+(10 000×10 000)=0.100481; q+/+(10 000
 ×10 000)=0.25372; the estimated p+(5000×5000)=0.0360614
Species 28: p+(10 000×10 000)=0.0755789; q+/+(10 000
 ×10 000)=0.585283; the estimated p+(5000×5000)=0.0467228
Species 29: p+(10 000×10 000)=0.273482; q+/+(10 000
 ×10 000)=0.748106; the estimated p+(5000×5000)=0.203254
Species 30: p+(10 000×10 000)=0.0624727; q+/+(10 000
 ×10 000)=0.446009; the estimated p+(5000×5000)=0.0318448
Species 31: p+(10 000×10 000)=0.390127; q+/+(10 000
 ×10 000)=0.609041; the estimated p+(5000×5000)=0.219384
Species 32: p+(10 000×10 000)=0.140673; q+/+(10 000
 ×10 000)=0.603583; the estimated p+(5000×5000)=0.0877376
Species 33: p+(10 000×10 000)=0.0336391; q+/+(10 000
 ×10 000)=0.422149; the estimated p+(5000×5000)=0.0167682
Species 34: p+(10 000×10 000)=0.0764526; q+/+(10 000
 ×10 000)=0.380329; the estimated p+(5000×5000)=0.0349471
Species 35: p+(10 000×10 000)=0.024028; q+/+(10 000
 ×10 000)=0.566358; the estimated p+(5000×5000)=0.0146608
Species 36: p+(10 000×10 000)=0.0332023; q+/+(10 000
 ×10 000)=0.463816; the estimated p+(5000×5000)=0.017577
Species 37: p+(10 000×10 000)=0.0244648; q+/+(10 000
 ×10 000)=0.523148; the estimated p+(5000×5000)=0.0140962
Species 38: p+(10 000×10 000)=0.0144168; q+/+(10 000
 ×10 000)=0.669192; the estimated p+(5000×5000)=0.0100246
Species 39: p+(10 000×10 000)=0.00655308; q+/+(
 10 000×10 000)=0.3; the estimated p+(5000×5000)=0.0027571
Species 40: p+(10 000×10 000)=0.08519; q+/+(10 000
 ×10 000)=0.295614; the estimated p+(5000×5000)=0.0335304
Species 41: p+(10 000×10 000)=0.0506772; q+/+(10 000
 ×10 000)=0.189732; the estimated p+(5000×5000)=0.017039
```

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_5km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
 (*You can export the results into a dat file that can be read
 by Excel. Remember to change the path and you file name*)
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_5km.dat
```

```
(* 10x10 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
      Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 1;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
```

$$z = \text{FindRoot}\Big[p0\left(p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2\,(-1+n)}\left(\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}\right)\Big/\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}+\frac{p0^{2}\left(1-p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2}}{1-p0}\right)\right)^{(-1+n)^{2}} == p100,\ \{p0,\ (p100+1)/2\}\Big][[1, 2]];$$

```
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p₊(", unit, "×",
    unit, ")=", p[j - 2], "; q₊/₊(", unit, "×", unit, ")=", q[j - 2],
    "; the estimated p₊(", unit / n, "×", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

```
Species 1: p₊(10 000×10 000)=0.809524; q₊/₊(10 000
 ×10 000)=0.862347; the estimated p₊(10 000×10 000)=0.809524
```

Species 2: $p_+(10\,000\times10\,000)$=0.387942; $q_{+/+}(10\,000\times10\,000)$=0.788527; the estimated $p_+(10\,000\times10\,000)$=0.387942

Species 3: $p_+(10\,000\times10\,000)$=0.760157; $q_{+/+}(10\,000\times10\,000)$=0.860525; the estimated $p_+(10\,000\times10\,000)$=0.760157

Species 4: $p_+(10\,000\times10\,000)$=0.819572; $q_{+/+}(10\,000\times10\,000)$=0.870532; the estimated $p_+(10\,000\times10\,000)$=0.819572

Species 5: $p_+(10\,000\times10\,000)$=0.188729; $q_{+/+}(10\,000\times10\,000)$=0.668632; the estimated $p_+(10\,000\times10\,000)$=0.188729

Species 6: $p_+(10\,000\times10\,000)$=0.579292; $q_{+/+}(10\,000\times10\,000)$=0.85079; the estimated $p_+(10\,000\times10\,000)$=0.579292

Species 7: $p_+(10\,000\times10\,000)$=0.49716; $q_{+/+}(10\,000\times10\,000)$=0.840835; the estimated $p_+(10\,000\times10\,000)$=0.49716

Species 8: $p_+(10\,000\times10\,000)$=0.51682; $q_{+/+}(10\,000\times10\,000)$=0.847151; the estimated $p_+(10\,000\times10\,000)$=0.51682

Species 9: $p_+(10\,000\times10\,000)$=0.400612; $q_{+/+}(10\,000\times10\,000)$=0.866556; the estimated $p_+(10\,000\times10\,000)$=0.400612

Species 10: $p_+(10\,000\times10\,000)$=0.632591; $q_{+/+}(10\,000\times10\,000)$=0.76601; the estimated $p_+(10\,000\times10\,000)$=0.632591

Species 11: $p_+(10\,000\times10\,000)$=0.623416; $q_{+/+}(10\,000\times10\,000)$=0.857592; the estimated $p_+(10\,000\times10\,000)$=0.623416

Species 12: $p_+(10\,000\times10\,000)$=0.26955; $q_{+/+}(10\,000\times10\,000)$=0.789825; the estimated $p_+(10\,000\times10\,000)$=0.26955

Species 13: $p_+(10\,000\times10\,000)$=0.455221; $q_{+/+}(10\,000\times10\,000)$=0.807251; the estimated $p_+(10\,000\times10\,000)$=0.455221

Species 14: $p_+(10\,000\times10\,000)$=0.414592; $q_{+/+}(10\,000\times10\,000)$=0.768369; the estimated $p_+(10\,000\times10\,000)$=0.414592

Species 15: $p_+(10\,000\times10\,000)$=0.536916; $q_{+/+}(10\,000\times10\,000)$=0.749098; the estimated $p_+(10\,000\times10\,000)$=0.536916

Species 16: $p_+(10\,000\times10\,000)$=0.041066; $q_{+/+}(10\,000\times10\,000)$=0.554078; the estimated $p_+(10\,000\times10\,000)$=0.041066

Species 17: $p_+(10\,000\times10\,000)$=0.408038; $q_{+/+}(10\,000\times10\,000)$=0.787138; the estimated $p_+(10\,000\times10\,000)$=0.408038

Species 18: $p_+(10\,000\times10\,000)$=0.644823; $q_{+/+}(10\,000\times10\,000)$=0.742461; the estimated $p_+(10\,000\times10\,000)$=0.644823

Species 19: $p_+(10\,000\times10\,000)$=0.155526; $q_{+/+}(10\,000\times10\,000)$=0.70033; the estimated $p_+(10\,000\times10\,000)$=0.155526

Species 20: $p_+(10\,000\times10\,000)$=0.457842; $q_{+/+}(10\,000\times10\,000)$=0.839762; the estimated $p_+(10\,000\times10\,000)$=0.457842

Species 21: $p_+(10\,000\times10\,000)$=0.766273; $q_{+/+}(10\,000\times10\,000)$=0.857524; the estimated $p_+(10\,000\times10\,000)$=0.766273

Species 22: $p_+(10\,000\times10\,000)$=0.0144168; $q_{+/+}(10\,000\times10\,000)$=0.462121; the estimated $p_+(10\,000\times10\,000)$=0.0144168

Species 23: $p_+(10\,000\times10\,000)$=0.0449978; $q_{+/+}(10\,000\times10\,000)$=0.50817; the estimated $p_+(10\,000\times10\,000)$=0.0449978

Species 24: $p_+(10\,000\times10\,000)$=0.131498; $q_{+/+}(10\,000\times10\,000)$=0.562287; the estimated $p_+(10\,000\times10\,000)$=0.131498

Species 25: $p_+(10\,000\times10\,000)$=0.0222805; $q_{+/+}(10\,000\times10\,000)$=0.367647; the estimated $p_+(10\,000\times10\,000)$=0.0222805

Species 26: $p_+(10\,000\times10\,000)$=0.0624727; $q_{+/+}(10\,000\times10\,000)$=0.46256; the estimated $p_+(10\,000\times10\,000)$=0.0624727

Species 27: p_+(10 000×10 000)=0.100481; $q_{+/+}$(10 000
×10 000)=0.25372; the estimated p_+(10 000×10 000)=0.100481

Species 28: p_+(10 000×10 000)=0.0755789; $q_{+/+}$(10 000
×10 000)=0.585283; the estimated p_+(10 000×10 000)=0.0755789

Species 29: p_+(10 000×10 000)=0.273482; $q_{+/+}$(10 000
×10 000)=0.748106; the estimated p_+(10 000×10 000)=0.273482

Species 30: p_+(10 000×10 000)=0.0624727; $q_{+/+}$(10 000
×10 000)=0.446009; the estimated p_+(10 000×10 000)=0.0624727

Species 31: p_+(10 000×10 000)=0.390127; $q_{+/+}$(10 000
×10 000)=0.609041; the estimated p_+(10 000×10 000)=0.390127

Species 32: p_+(10 000×10 000)=0.140673; $q_{+/+}$(10 000
×10 000)=0.603583; the estimated p_+(10 000×10 000)=0.140673

Species 33: p_+(10 000×10 000)=0.0336391; $q_{+/+}$(10 000
×10 000)=0.422149; the estimated p_+(10 000×10 000)=0.0336391

Species 34: p_+(10 000×10 000)=0.0764526; $q_{+/+}$(10 000
×10 000)=0.380329; the estimated p_+(10 000×10 000)=0.0764526

Species 35: p_+(10 000×10 000)=0.024028; $q_{+/+}$(10 000
×10 000)=0.566358; the estimated p_+(10 000×10 000)=0.024028

Species 36: p_+(10 000×10 000)=0.0332023; $q_{+/+}$(10 000
×10 000)=0.463816; the estimated p_+(10 000×10 000)=0.0332023

Species 37: p_+(10 000×10 000)=0.0244648; $q_{+/+}$(10 000
×10 000)=0.523148; the estimated p_+(10 000×10 000)=0.0244648

Species 38: p_+(10 000×10 000)=0.0144168; $q_{+/+}$(10 000
×10 000)=0.669192; the estimated p_+(10 000×10 000)=0.0144168

Species 39: p_+(10 000×10 000)=0.00655308; $q_{+/+}$(
10 000×10 000)=0.3; the estimated p_+(10 000×10 000)=0.00655308

Species 40: p_+(10 000×10 000)=0.08519; $q_{+/+}$(10 000
×10 000)=0.295614; the estimated p_+(10 000×10 000)=0.08519

Species 41: p_+(10 000×10 000)=0.0506772; $q_{+/+}$(10 000
×10 000)=0.189732; the estimated p_+(10 000×10 000)=0.0506772

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_10km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
 (*You can export the results into a dat file that can be read
 by Excel. Remember to change the path and you file name*)
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_10km.dat
```

```
(* 12x12 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
       Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 10 / 12;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
z = FindRoot[p0 (p0^(-1/(-1+n)) p100^(1/(-1+n)) q100^(-1/n))^(2 (-1+n))
     ((p0^(1-2/(-1+n)) p100^(2/(-1+n)) q100^(-2/n)) /
      (p0^(1-2/(-1+n)) p100^(2/(-1+n)) q100^(-2/n) +
        p0^2 (1 - p0^(-1/(-1+n)) p100^(1/(-1+n)) q100^(-1/n))^2 / (1 - p0)))^((-1+n)^2) ==
       p100, {p0, (p100 + 1) / 2}][[1, 2]];
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p+(", unit, "x",
    unit, ")=", p[j - 2], "; q+/+(", unit, "x", unit, ")=", q[j - 2],
    "; the estimated p+(", unit / n, "x", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

```
Species 1: p+(10 000×10 000)=0.809524; q+/+(10 000
 ×10 000)=0.862347; the estimated p+(12 000×12 000)=0.867967
```

Species 2: $p_+(10\,000\times10\,000)$=0.387942; $q_{+/+}(10\,000\times10\,000)$=0.788527; the estimated $p_+(12\,000\times12\,000)$=0.423024

Species 3: $p_+(10\,000\times10\,000)$=0.760157; $q_{+/+}(10\,000\times10\,000)$=0.860525; the estimated $p_+(12\,000\times12\,000)$=0.811384

Species 4: $p_+(10\,000\times10\,000)$=0.819572; $q_{+/+}(10\,000\times10\,000)$=0.870532; the estimated $p_+(12\,000\times12\,000)$=0.875235

Species 5: $p_+(10\,000\times10\,000)$=0.188729; $q_{+/+}(10\,000\times10\,000)$=0.668632; the estimated $p_+(12\,000\times12\,000)$=0.21527

Species 6: $p_+(10\,000\times10\,000)$=0.579292; $q_{+/+}(10\,000\times10\,000)$=0.85079; the estimated $p_+(12\,000\times12\,000)$=0.616975

Species 7: $p_+(10\,000\times10\,000)$=0.49716; $q_{+/+}(10\,000\times10\,000)$=0.840835; the estimated $p_+(12\,000\times12\,000)$=0.531084

Species 8: $p_+(10\,000\times10\,000)$=0.51682; $q_{+/+}(10\,000\times10\,000)$=0.847151; the estimated $p_+(12\,000\times12\,000)$=0.550736

Species 9: $p_+(10\,000\times10\,000)$=0.400612; $q_{+/+}(10\,000\times10\,000)$=0.866556; the estimated $p_+(12\,000\times12\,000)$=0.422921

Species 10: $p_+(10\,000\times10\,000)$=0.632591; $q_{+/+}(10\,000\times10\,000)$=0.76601; the estimated $p_+(12\,000\times12\,000)$=0.70378

Species 11: $p_+(10\,000\times10\,000)$=0.623416; $q_{+/+}(10\,000\times10\,000)$=0.857592; the estimated $p_+(12\,000\times12\,000)$=0.662545

Species 12: $p_+(10\,000\times10\,000)$=0.26955; $q_{+/+}(10\,000\times10\,000)$=0.789825; the estimated $p_+(12\,000\times12\,000)$=0.293293

Species 13: $p_+(10\,000\times10\,000)$=0.455221; $q_{+/+}(10\,000\times10\,000)$=0.807251; the estimated $p_+(12\,000\times12\,000)$=0.493036

Species 14: $p_+(10\,000\times10\,000)$=0.414592; $q_{+/+}(10\,000\times10\,000)$=0.768369; the estimated $p_+(12\,000\times12\,000)$=0.456213

Species 15: $p_+(10\,000\times10\,000)$=0.536916; $q_{+/+}(10\,000\times10\,000)$=0.749098; the estimated $p_+(12\,000\times12\,000)$=0.598539

Species 16: $p_+(10\,000\times10\,000)$=0.041066; $q_{+/+}(10\,000\times10\,000)$=0.554078; the estimated $p_+(12\,000\times12\,000)$=0.0487682

Species 17: $p_+(10\,000\times10\,000)$=0.408038; $q_{+/+}(10\,000\times10\,000)$=0.787138; the estimated $p_+(12\,000\times12\,000)$=0.445359

Species 18: $p_+(10\,000\times10\,000)$=0.644823; $q_{+/+}(10\,000\times10\,000)$=0.742461; the estimated $p_+(12\,000\times12\,000)$=0.727772

Species 19: $p_+(10\,000\times10\,000)$=0.155526; $q_{+/+}(10\,000\times10\,000)$=0.70033; the estimated $p_+(12\,000\times12\,000)$=0.17509

Species 20: $p_+(10\,000\times10\,000)$=0.457842; $q_{+/+}(10\,000\times10\,000)$=0.839762; the estimated $p_+(12\,000\times12\,000)$=0.489047

Species 21: $p_+(10\,000\times10\,000)$=0.766273; $q_{+/+}(10\,000\times10\,000)$=0.857524; the estimated $p_+(12\,000\times12\,000)$=0.819747

Species 22: $p_+(10\,000\times10\,000)$=0.0144168; $q_{+/+}(10\,000\times10\,000)$=0.462121; the estimated $p_+(12\,000\times12\,000)$=0.0176944

Species 23: $p_+(10\,000\times10\,000)$=0.0449978; $q_{+/+}(10\,000\times10\,000)$=0.50817; the estimated $p_+(12\,000\times12\,000)$=0.0543614

Species 24: $p_+(10\,000\times10\,000)$=0.131498; $q_{+/+}(10\,000\times10\,000)$=0.562287; the estimated $p_+(12\,000\times12\,000)$=0.156098

Species 25: $p_+(10\,000\times10\,000)$=0.0222805; $q_{+/+}(10\,000\times10\,000)$=0.367647; the estimated $p_+(12\,000\times12\,000)$=0.0283035

Species 26: $p_+(10\,000\times10\,000)$=0.0624727; $q_{+/+}(10\,000\times10\,000)$=0.46256; the estimated $p_+(12\,000\times12\,000)$=0.0768059

Species 27: p_+(10 000×10 000)=0.100481; $q_{+/+}$(10 000 ×10 000)=0.25372; the estimated p_+(12 000×12 000)=0.133738

Species 28: p_+(10 000×10 000)=0.0755789; $q_{+/+}$(10 000 ×10 000)=0.585283; the estimated p_+(12 000×12 000)=0.0887902

Species 29: p_+(10 000×10 000)=0.273482; $q_{+/+}$(10 000 ×10 000)=0.748106; the estimated p_+(12 000×12 000)=0.302657

Species 30: p_+(10 000×10 000)=0.0624727; $q_{+/+}$(10 000 ×10 000)=0.446009; the estimated p_+(12 000×12 000)=0.077277

Species 31: p_+(10 000×10 000)=0.390127; $q_{+/+}$(10 000 ×10 000)=0.609041; the estimated p_+(12 000×12 000)=0.459881

Species 32: p_+(10 000×10 000)=0.140673; $q_{+/+}$(10 000 ×10 000)=0.603583; the estimated p_+(12 000×12 000)=0.164394

Species 33: p_+(10 000×10 000)=0.0336391; $q_{+/+}$(10 000 ×10 000)=0.422149; the estimated p_+(12 000×12 000)=0.0419229

Species 34: p_+(10 000×10 000)=0.0764526; $q_{+/+}$(10 000 ×10 000)=0.380329; the estimated p_+(12 000×12 000)=0.0969556

Species 35: p_+(10 000×10 000)=0.024028; $q_{+/+}$(10 000 ×10 000)=0.566358; the estimated p_+(12 000×12 000)=0.0283925

Species 36: p_+(10 000×10 000)=0.0332023; $q_{+/+}$(10 000 ×10 000)=0.463816; the estimated p_+(12 000×12 000)=0.040754

Species 37: p_+(10 000×10 000)=0.0244648; $q_{+/+}$(10 000 ×10 000)=0.523148; the estimated p_+(12 000×12 000)=0.0293741

Species 38: p_+(10 000×10 000)=0.0144168; $q_{+/+}$(10 000 ×10 000)=0.669192; the estimated p_+(12 000×12 000)=0.0163907

Species 39: p_+(10 000×10 000)=0.00655308; $q_{+/+}$(10 000×10 000)=0.3; the estimated p_+(12 000×12 000)=0.00851966

Species 40: p_+(10 000×10 000)=0.08519; $q_{+/+}$(10 000 ×10 000)=0.295614; the estimated p_+(12 000×12 000)=0.111515

Species 41: p_+(10 000×10 000)=0.0506772; $q_{+/+}$(10 000 ×10 000)=0.189732; the estimated p_+(12 000×12 000)=0.0687206

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_12km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
 (*You can export the results into a dat file that can be read
 by Excel. Remember to change the path and you file name*)
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_12km.dat
```

```
(* 20x20 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
      Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
           If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 1 / 2;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
```

$$z = \text{FindRoot}\Big[p0\left(p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2(-1+n)}\left(\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}\right)\Big/\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}+\frac{p0^{2}\left(1-p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2}}{1-p0}\right)\right)^{(-1+n)^{2}} == p100,\ \{p0,\ (p100+1)/2\}\Big][[1, 2]];$$

```
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p+(", unit, "×",
    unit, ")=", p[j - 2], "; q+/+(", unit, "×", unit, ")=", q[j - 2],
    "; the estimated p+(", unit / n, "×", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

Species 1: p_+(10 000×10 000)=0.809524; $q_{+/+}$(10 000 ×10 000)=0.862347; the estimated p_+(20 000×20 000)=0.975549

Species 2: p_+(10 000×10 000)=0.387942; $q_{+/+}$(10 000 ×10 000)=0.788527; the estimated p_+(20 000×20 000)=0.55636

Species 3: p_+(10 000×10 000)=0.760157; $q_{+/+}$(10 000 ×10 000)=0.860525; the estimated p_+(20 000×20 000)=0.934801

Species 4: p_+(10 000×10 000)=0.819572; $q_{+/+}$(10 000 ×10 000)=0.870532; the estimated p_+(20 000×20 000)=0.976827

Species 5: p_+(10 000×10 000)=0.188729; $q_{+/+}$(10 000 ×10 000)=0.668632; the estimated p_+(20 000×20 000)=0.328373

Species 6: p_+(10 000×10 000)=0.579292; $q_{+/+}$(10 000 ×10 000)=0.85079; the estimated p_+(20 000×20 000)=0.744985

Species 7: p_+(10 000×10 000)=0.49716; $q_{+/+}$(10 000 ×10 000)=0.840835; the estimated p_+(20 000×20 000)=0.653814

Species 8: p_+(10 000×10 000)=0.51682; $q_{+/+}$(10 000 ×10 000)=0.847151; the estimated p_+(20 000×20 000)=0.672225

Species 9: p_+(10 000×10 000)=0.400612; $q_{+/+}$(10 000 ×10 000)=0.866556; the estimated p_+(20 000×20 000)=0.509316

Species 10: p_+(10 000×10 000)=0.632591; $q_{+/+}$(10 000 ×10 000)=0.76601; the estimated p_+(20 000×20 000)=0.892532

Species 11: p_+(10 000×10 000)=0.623416; $q_{+/+}$(10 000 ×10 000)=0.857592; the estimated p_+(20 000×20 000)=0.790096

Species 12: p_+(10 000×10 000)=0.26955; $q_{+/+}$(10 000 ×10 000)=0.789825; the estimated p_+(20 000×20 000)=0.389555

Species 13: p_+(10 000×10 000)=0.455221; $q_{+/+}$(10 000 ×10 000)=0.807251; the estimated p_+(20 000×20 000)=0.631126

Species 14: p_+(10 000×10 000)=0.414592; $q_{+/+}$(10 000 ×10 000)=0.768369; the estimated p_+(20 000×20 000)=0.610043

Species 15: p_+(10 000×10 000)=0.536916; $q_{+/+}$(10 000 ×10 000)=0.749098; the estimated p_+(20 000×20 000)=0.792952

Species 16: p_+(10 000×10 000)=0.041066; $q_{+/+}$(10 000 ×10 000)=0.554078; the estimated p_+(20 000×20 000)=0.0853789

Species 17: p_+(10 000×10 000)=0.408038; $q_{+/+}$(10 000 ×10 000)=0.787138; the estimated p_+(20 000×20 000)=0.585156

Species 18: p_+(10 000×10 000)=0.644823; $q_{+/+}$(10 000 ×10 000)=0.742461; the estimated p_+(20 000×20 000)=0.926256

Species 19: p_+(10 000×10 000)=0.155526; $q_{+/+}$(10 000 ×10 000)=0.70033; the estimated p_+(20 000×20 000)=0.259478

Species 20: p_+(10 000×10 000)=0.457842; $q_{+/+}$(10 000 ×10 000)=0.839762; the estimated p_+(20 000×20 000)=0.604985

Species 21: p_+(10 000×10 000)=0.766273; $q_{+/+}$(10 000 ×10 000)=0.857524; the estimated p_+(20 000×20 000)=0.943328

Species 22: p_+(10 000×10 000)=0.0144168; $q_{+/+}$(10 000 ×10 000)=0.462121; the estimated p_+(20 000×20 000)=0.0340092

Species 23: p_+(10 000×10 000)=0.0449978; $q_{+/+}$(10 000 ×10 000)=0.50817; the estimated p_+(20 000×20 000)=0.0994277

Species 24: p_+(10 000×10 000)=0.131498; $q_{+/+}$(10 000 ×10 000)=0.562287; the estimated p_+(20 000×20 000)=0.266637

Species 25: p_+(10 000×10 000)=0.0222805; $q_{+/+}$(10 000 ×10 000)=0.367647; the estimated p_+(20 000×20 000)=0.0590608

Species 26: p_+(10 000×10 000)=0.0624727; $q_{+/+}$(10 000 ×10 000)=0.46256; the estimated p_+(20 000×20 000)=0.145944

Species 27: p_+(10 000×10 000)=0.100481; $q_{+/+}$(10 000 ×10 000)=0.25372; the estimated p_+(20 000×20 000)=0.296115

Species 28: p_+(10 000×10 000)=0.0755789; $q_{+/+}$(10 000 ×10 000)=0.585283; the estimated p_+(20 000×20 000)=0.14984

Species 29: p_+(10 000×10 000)=0.273482; $q_{+/+}$(10 000 ×10 000)=0.748106; the estimated p_+(20 000×20 000)=0.420665

Species 30: p_+(10 000×10 000)=0.0624727; $q_{+/+}$(10 000 ×10 000)=0.446009; the estimated p_+(20 000×20 000)=0.149016

Species 31: p_+(10 000×10 000)=0.390127; $q_{+/+}$(10 000 ×10 000)=0.609041; the estimated p_+(20 000×20 000)=0.704718

Species 32: p_+(10 000×10 000)=0.140673; $q_{+/+}$(10 000 ×10 000)=0.603583; the estimated p_+(20 000×20 000)=0.269512

Species 33: p_+(10 000×10 000)=0.0336391; $q_{+/+}$(10 000 ×10 000)=0.422149; the estimated p_+(20 000×20 000)=0.083175

Species 34: p_+(10 000×10 000)=0.0764526; $q_{+/+}$(10 000 ×10 000)=0.380329; the estimated p_+(20 000×20 000)=0.196905

Species 35: p_+(10 000×10 000)=0.024028; $q_{+/+}$(10 000 ×10 000)=0.566358; the estimated p_+(20 000×20 000)=0.0492345

Species 36: p_+(10 000×10 000)=0.0332023; $q_{+/+}$(10 000 ×10 000)=0.463816; the estimated p_+(20 000×20 000)=0.077883

Species 37: p_+(10 000×10 000)=0.0244648; $q_{+/+}$(10 000 ×10 000)=0.523148; the estimated p_+(20 000×20 000)=0.0531664

Species 38: p_+(10 000×10 000)=0.0144168; $q_{+/+}$(10 000 ×10 000)=0.669192; the estimated p_+(20 000×20 000)=0.0255033

Species 39: p_+(10 000×10 000)=0.00655308; $q_{+/+}$(10 000×10 000)=0.3; the estimated p_+(20 000×20 000)=0.018905

Species 40: p_+(10 000×10 000)=0.08519; $q_{+/+}$(10 000 ×10 000)=0.295614; the estimated p_+(20 000×20 000)=0.241205

Species 41: p_+(10 000×10 000)=0.0506772; $q_{+/+}$(10 000 ×10 000)=0.189732; the estimated p_+(20 000×20 000)=0.163026

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_20km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
 (*You can export the results into a dat file that can be read
 by Excel. Remember to change the path and you file name*)
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_20km.dat
```

```
(* 40x40 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
      Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 1 / 4;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
```

$$z = \text{FindRoot}\left[p0\left(p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2(-1+n)}\left(\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}\right)\Big/\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}+\frac{p0^2\left(1-p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^2}{1-p0}\right)\right)^{(-1+n)^2} == p100,\ \{p0,\ (p100+1)/2\}\right][[1, 2]];$$

```
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p+(", unit, "x",
    unit, ")=", p[j - 2], "; q+/+(", unit, "x", unit, ")=", q[j - 2],
    "; the estimated p+(", unit / n, "x", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

```
Species 1: p+(10 000×10 000)=0.809524; q+/+(10 000×10 000)=
   0.862347; the estimated p+(40 000×40 000)=0.999781 + 6.29464 × 10^-24 i
```

Species 2: $p_+(10\,000\times10\,000)=0.387942$; $q_{+/+}(10\,000\times10\,000)=0.788527$; the estimated $p_+(40\,000\times40\,000)=1.22867-0.228669\,i$

Species 3: $p_+(10\,000\times10\,000)=0.760157$; $q_{+/+}(10\,000\times10\,000)=0.860525$; the estimated $p_+(40\,000\times40\,000)=0.996069-6.48986\times10^{-24}\,i$

Species 4: $p_+(10\,000\times10\,000)=0.819572$; $q_{+/+}(10\,000\times10\,000)=0.870532$; the estimated $p_+(40\,000\times40\,000)=0.999769+1.35748\times10^{-22}\,i$

Species 5: $p_+(10\,000\times10\,000)=0.188729$; $q_{+/+}(10\,000\times10\,000)=0.668632$; the estimated $p_+(40\,000\times40\,000)=0.601309$

Species 6: $p_+(10\,000\times10\,000)=0.579292$; $q_{+/+}(10\,000\times10\,000)=0.85079$; the estimated $p_+(40\,000\times40\,000)=0.917736+2.39814\times10^{-28}\,i$

Species 7: $p_+(10\,000\times10\,000)=0.49716$; $q_{+/+}(10\,000\times10\,000)=0.840835$; the estimated $p_+(40\,000\times40\,000)=1.1413-0.1413\,i$

Species 8: $p_+(10\,000\times10\,000)=0.51682$; $q_{+/+}(10\,000\times10\,000)=0.847151$; the estimated $p_+(40\,000\times40\,000)=0.865417+2.01563\times10^{-20}\,i$

Species 9: $p_+(10\,000\times10\,000)=0.400612$; $q_{+/+}(10\,000\times10\,000)=0.866556$; the estimated $p_+(40\,000\times40\,000)=0.690651$

Species 10: $p_+(10\,000\times10\,000)=0.632591$; $q_{+/+}(10\,000\times10\,000)=0.76601$; the estimated $p_+(40\,000\times40\,000)=0.994563-9.76662\times10^{-19}\,i$

Species 11: $p_+(10\,000\times10\,000)=0.623416$; $q_{+/+}(10\,000\times10\,000)=0.857592$; the estimated $p_+(40\,000\times40\,000)=1.06642+0.0481514\,i$

Species 12: $p_+(10\,000\times10\,000)=0.26955$; $q_{+/+}(10\,000\times10\,000)=0.789825$; the estimated $p_+(40\,000\times40\,000)=0.609356$

Species 13: $p_+(10\,000\times10\,000)=0.455221$; $q_{+/+}(10\,000\times10\,000)=0.807251$; the estimated $p_+(40\,000\times40\,000)=1.24021-0.240205\,i$

Species 14: $p_+(10\,000\times10\,000)=0.414592$; $q_{+/+}(10\,000\times10\,000)=0.768369$; the estimated $p_+(40\,000\times40\,000)=0.856187+9.5402\times10^{-19}\,i$

Species 15: $p_+(10\,000\times10\,000)=0.536916$; $q_{+/+}(10\,000\times10\,000)=0.749098$; the estimated $p_+(40\,000\times40\,000)=0.970764-2.19082\times10^{-22}\,i$

Species 16: $p_+(10\,000\times10\,000)=0.041066$; $q_{+/+}(10\,000\times10\,000)=0.554078$; the estimated $p_+(40\,000\times40\,000)=0.209165$

Species 17: $p_+(10\,000\times10\,000)=0.408038$; $q_{+/+}(10\,000\times10\,000)=0.787138$; the estimated $p_+(40\,000\times40\,000)=1.23876-0.238763\,i$

Species 18: $p_+(10\,000\times10\,000)=0.644823$; $q_{+/+}(10\,000\times10\,000)=0.742461$; the estimated $p_+(40\,000\times40\,000)=1.00139-0.00469791\,i$

Species 19: $p_+(10\,000\times10\,000)=0.155526$; $q_{+/+}(10\,000\times10\,000)=0.70033$; the estimated $p_+(40\,000\times40\,000)=0.481527$

Species 20: $p_+(10\,000\times10\,000)=0.457842$; $q_{+/+}(10\,000\times10\,000)=0.839762$; the estimated $p_+(40\,000\times40\,000)=1.22754-0.227542\,i$

Species 21: $p_+(10\,000\times10\,000)=0.766273$; $q_{+/+}(10\,000\times10\,000)=0.857524$; the estimated $p_+(40\,000\times40\,000)=0.997362-9.88916\times10^{-27}\,i$

Species 22: $p_+(10\,000\times10\,000)=0.0144168$; $q_{+/+}(10\,000\times10\,000)=0.462121$; the estimated $p_+(40\,000\times40\,000)=0.0953267$

Species 23: $p_+(10\,000\times10\,000)=0.0449978$; $q_{+/+}(10\,000\times10\,000)=0.50817$; the estimated $p_+(40\,000\times40\,000)=0.252034$

Species 24: $p_+(10\,000\times10\,000)=0.131498$; $q_{+/+}(10\,000\times10\,000)=0.562287$; the estimated $p_+(40\,000\times40\,000)=0.55942$

Species 25: $p_+(10\,000\times10\,000)=0.0222805$; $q_{+/+}(10\,000\times10\,000)=0.367647$; the estimated $p_+(40\,000\times40\,000)=0.175307$

Species 26: $p_+(10\,000\times10\,000)=0.0624727$; $q_{+/+}(10\,000\times10\,000)=0.46256$; the estimated $p_+(40\,000\times40\,000)=0.369161$

```
Species 27: p₊(10 000×10 000)=0.100481; q₊/₊(10 000
 ×10 000)=0.25372; the estimated p₊(40 000×40 000)=0.716407

Species 28: p₊(10 000×10 000)=0.0755789; q₊/₊(10 000
 ×10 000)=0.585283; the estimated p₊(40 000×40 000)=0.338285

Species 29: p₊(10 000×10 000)=0.273482; q₊/₊(10 000
 ×10 000)=0.748106; the estimated p₊(40 000×40 000)=0.675699

Species 30: p₊(10 000×10 000)=0.0624727; q₊/₊(10 000
 ×10 000)=0.446009; the estimated p₊(40 000×40 000)=0.380754

Species 31: p₊(10 000×10 000)=0.390127; q₊/₊(10 000×10 000)=
  0.609041; the estimated p₊(40 000×40 000)=0.963382 - 1.38205 × 10^-17 i

Species 32: p₊(10 000×10 000)=0.140673; q₊/₊(10 000
 ×10 000)=0.603583; the estimated p₊(40 000×40 000)=0.545461

Species 33: p₊(10 000×10 000)=0.0336391; q₊/₊(10 000
 ×10 000)=0.422149; the estimated p₊(40 000×40 000)=0.230776

Species 34: p₊(10 000×10 000)=0.0764526; q₊/₊(10 000
 ×10 000)=0.380329; the estimated p₊(40 000×40 000)=0.501771

Species 35: p₊(10 000×10 000)=0.024028; q₊/₊(10 000
 ×10 000)=0.566358; the estimated p₊(40 000×40 000)=0.122329

Species 36: p₊(10 000×10 000)=0.0332023; q₊/₊(10 000
 ×10 000)=0.463816; the estimated p₊(40 000×40 000)=0.209544

Species 37: p₊(10 000×10 000)=0.0244648; q₊/₊(10 000
 ×10 000)=0.523148; the estimated p₊(40 000×40 000)=0.138007

Species 38: p₊(10 000×10 000)=0.0144168; q₊/₊(10 000
 ×10 000)=0.669192; the estimated p₊(40 000×40 000)=0.0563698

Species 39: p₊(10 000×10 000)=0.00655308; q₊/₊(
 10 000×10 000)=0.3; the estimated p₊(40 000×40 000)=0.0616032

Species 40: p₊(10 000×10 000)=0.08519; q₊/₊(10 000
 ×10 000)=0.295614; the estimated p₊(40 000×40 000)=0.612935

Species 41: p₊(10 000×10 000)=0.0506772; q₊/₊(10 000
 ×10 000)=0.189732; the estimated p₊(40 000×40 000)=0.47967
```

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_40km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
 (*You can export the results into a dat file that can be read
 by Excel. Remember to change the path and you file name*)
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_40km.dat
```

```
(* 80x80 km grain *)
```

```
Do[{
    d = Table[a[[i, j]], {i, 2, d1}]; occup = Total[d];
    p[j - 2] = 1.0 occup / (d1 - 1); pos = Flatten[Position[d, 1]];
    Do[{
        x = a[[pos[[i]] + 1, 1]]; y = a[[pos[[i]] + 1, 2]];
        n1 =
      Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}], {x + unit, y}]];
        n2 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x - unit, y}]];
        n3 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y + unit}]];
        n4 = Flatten[Position[Table[{a[[k, 1]], a[[k, 2]]}, {k, 2, d1}],
         {x, y - unit}]];
        nn = Length[n1] + Length[n2] + Length[n3] + Length[n4];
        mm = If[Length[n1] == 0, 0, d[[n1[[1]]]]] + If[Length[n2] == 0,
         0, d[[n2[[1]]]]] + If[Length[n3] == 0, 0, d[[n3[[1]]]]] +
            If[Length[n4] == 0, 0, d[[n4[[1]]]]];
        qq[i] = If[nn == 0, -1, 1.0 mm / nn];
    }, {i, 1, occup}];
    u = Cases[Table[qq[i], {i, 1, occup}], Except[-1]]; q[j - 2] = Mean[u];
    p100 = 1 - p[j - 2]; q100 = 1 - ((1 - q[j - 2]) p[j - 2] / p100); n = 1 / 8;
       (* The linear resolution in km of
    occupancy you plan to estimate is unit/n; for example,
       we are here calculating occupancy at 1×1km resolution *)
       (* For instance, if you want to calculate occupancy at 2×2km
    resolution, then set n = 5; if at 5×5km resolution, set n = 2 *)
       (* Note that n does not have to be integer; so if you want to
    calcualte occupancy at 4×4km resolution, then set n = 10/4 = 5/2 *)
       (* Please the program prefers the format of n =
    5/2 rather than n = 2.5 for the machineray accuracy issue *)
```

$$z = \text{FindRoot}\Big[p0\left(p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^{2\,(-1+n)}\left(\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}\right)\Big/\left(p0^{1-\frac{2}{-1+n}}\,p100^{\frac{2}{-1+n}}\,q100^{-2/n}+\frac{p0^2\left(1-p0^{-\frac{1}{-1+n}}\,p100^{\frac{1}{-1+n}}\,q100^{-1/n}\right)^2}{1-p0}\right)\right)^{(-1+n)^2} == p100,\ \{p0,\ (p100+1)/2\}\Big][[1, 2]];$$

```
pp[j - 2] = 1 - z;
Print["Species ", a[[1, j]], ": p+(", unit, "×",
    unit, ")=", p[j - 2], "; q+/+(", unit, "×", unit, ")=", q[j - 2],
    "; the estimated p+(", unit / n, "×", unit / n, ")=", pp[j - 2]];
  },
  {j,
   3,
   d2}];
```

Species 1: $p_+(10\,000\times10\,000)=0.809524$; $q_{+/+}(10\,000\times10\,000)=0.862347$; the estimated $p_+(80\,000\times80\,000)=1.-9.86618\times10^{-16}\,i$

Species 2: $p_+(10\,000\times10\,000)=0.387942$; $q_{+/+}(10\,000\times10\,000)=0.788527$; the estimated $p_+(80\,000\times80\,000)=1.33964+3.46628\times10^{-15}\,i$

Species 3: $p_+(10\,000\times10\,000)=0.760157$; $q_{+/+}(10\,000\times10\,000)=0.860525$; the estimated $p_+(80\,000\times80\,000)=0.999976$

Species 4: $p_+(10\,000\times10\,000)=0.819572$; $q_{+/+}(10\,000\times10\,000)=0.870532$; the estimated $p_+(80\,000\times80\,000)=1.+3.90768\times10^{-10}\,i$

Species 5: $p_+(10\,000\times10\,000)=0.188729$; $q_{+/+}(10\,000\times10\,000)=0.668632$; the estimated $p_+(80\,000\times80\,000)=1.20035-3.22702\times10^{-10}\,i$

Species 6: $p_+(10\,000\times10\,000)=0.579292$; $q_{+/+}(10\,000\times10\,000)=0.85079$; the estimated $p_+(80\,000\times80\,000)=1.0044+2.37837\times10^{-15}\,i$

Species 7: $p_+(10\,000\times10\,000)=0.49716$; $q_{+/+}(10\,000\times10\,000)=0.840835$; the estimated $p_+(80\,000\times80\,000)=0.975027$

Species 8: $p_+(10\,000\times10\,000)=0.51682$; $q_{+/+}(10\,000\times10\,000)=0.847151$; the estimated $p_+(80\,000\times80\,000)=0.978012$

Species 9: $p_+(10\,000\times10\,000)=0.400612$; $q_{+/+}(10\,000\times10\,000)=0.866556$; the estimated $p_+(80\,000\times80\,000)=1.14383+3.65173\times10^{-15}\,i$

Species 10: $p_+(10\,000\times10\,000)=0.632591$; $q_{+/+}(10\,000\times10\,000)=0.76601$; the estimated $p_+(80\,000\times80\,000)=1.00007+2.03904\times10^{-15}\,i$

Species 11: $p_+(10\,000\times10\,000)=0.623416$; $q_{+/+}(10\,000\times10\,000)=0.857592$; the estimated $p_+(80\,000\times80\,000)=0.995424$

Species 12: $p_+(10\,000\times10\,000)=0.26955$; $q_{+/+}(10\,000\times10\,000)=0.789825$; the estimated $p_+(80\,000\times80\,000)=1.18508+1.28583\times10^{-8}\,i$

Species 13: $p_+(10\,000\times10\,000)=0.455221$; $q_{+/+}(10\,000\times10\,000)=0.807251$; the estimated $p_+(80\,000\times80\,000)=0.978049$

Species 14: $p_+(10\,000\times10\,000)=0.414592$; $q_{+/+}(10\,000\times10\,000)=0.768369$; the estimated $p_+(80\,000\times80\,000)=1.28628+2.98285\times10^{-15}\,i$

Species 15: $p_+(10\,000\times10\,000)=0.536916$; $q_{+/+}(10\,000\times10\,000)=0.749098$; the estimated $p_+(80\,000\times80\,000)=1.00317+1.86106\times10^{-15}\,i$

Species 16: $p_+(10\,000\times10\,000)=0.041066$; $q_{+/+}(10\,000\times10\,000)=0.554078$; the estimated $p_+(80\,000\times80\,000)=0.503799$

Species 17: $p_+(10\,000\times10\,000)=0.408038$; $q_{+/+}(10\,000\times10\,000)=0.787138$; the estimated $p_+(80\,000\times80\,000)=0.971181$

Species 18: $p_+(10\,000\times10\,000)=0.644823$; $q_{+/+}(10\,000\times10\,000)=0.742461$; the estimated $p_+(80\,000\times80\,000)=1.00002-4.33218\times10^{-6}\,i$

Species 19: $p_+(10\,000\times10\,000)=0.155526$; $q_{+/+}(10\,000\times10\,000)=0.70033$; the estimated $p_+(80\,000\times80\,000)=0.795126$

Species 20: $p_+(10\,000\times10\,000)=0.457842$; $q_{+/+}(10\,000\times10\,000)=0.839762$; the estimated $p_+(80\,000\times80\,000)=1.00701+1.66809\times10^{-15}\,i$

Species 21: $p_+(10\,000\times10\,000)=0.766273$; $q_{+/+}(10\,000\times10\,000)=0.857524$; the estimated $p_+(80\,000\times80\,000)=1.+1.96223\times10^{-15}\,i$

Species 22: $p_+(10\,000\times10\,000)=0.0144168$; $q_{+/+}(10\,000\times10\,000)=0.462121$; the estimated $p_+(80\,000\times80\,000)=0.279881$

Species 23: $p_+(10\,000\times10\,000)=0.0449978$; $q_{+/+}(10\,000\times10\,000)=0.50817$; the estimated $p_+(80\,000\times80\,000)=0.591028$

Species 24: $p_+(10\,000\times10\,000)=0.131498$; $q_{+/+}(10\,000\times10\,000)=0.562287$; the estimated $p_+(80\,000\times80\,000)=0.892973$

Species 25: $p_+(10\,000\times10\,000)=0.0222805$; $q_{+/+}(10\,000\times10\,000)=0.367647$; the estimated $p_+(80\,000\times80\,000)=0.485326$

Species 26: $p_+(10\,000\times10\,000)=0.0624727$; $q_{+/+}(10\,000\times10\,000)=0.46256$; the estimated $p_+(80\,000\times80\,000)=0.763325$

```
Species 27: p₊(10 000×10 000)=0.100481; q₊/₊(10 000
 ×10 000)=0.25372; the estimated p₊(80 000×80 000)=0.990701
Species 28: p₊(10 000×10 000)=0.0755789; q₊/₊(10 000
 ×10 000)=0.585283; the estimated p₊(80 000×80 000)=0.687739
Species 29: p₊(10 000×10 000)=0.273482; q₊/₊(10 000×10 000)=
  0.748106; the estimated p₊(80 000×80 000)=1.87051 + 4.61684 × 10^-15 i
Species 30: p₊(10 000×10 000)=0.0624727; q₊/₊(10 000
 ×10 000)=0.446009; the estimated p₊(80 000×80 000)=0.780697
Species 31: p₊(10 000×10 000)=0.390127; q₊/₊(10 000×10 000)=
  0.609041; the estimated p₊(80 000×80 000)=1.00416 + 1.61133 × 10^-15 i
Species 32: p₊(10 000×10 000)=0.140673; q₊/₊(10 000
 ×10 000)=0.603583; the estimated p₊(80 000×80 000)=0.873748
Species 33: p₊(10 000×10 000)=0.0336391; q₊/₊(10 000
 ×10 000)=0.422149; the estimated p₊(80 000×80 000)=0.57949
Species 34: p₊(10 000×10 000)=0.0764526; q₊/₊(10 000
 ×10 000)=0.380329; the estimated p₊(80 000×80 000)=0.899838
Species 35: p₊(10 000×10 000)=0.024028; q₊/₊(10 000
 ×10 000)=0.566358; the estimated p₊(80 000×80 000)=0.324492
Species 36: p₊(10 000×10 000)=0.0332023; q₊/₊(10 000
 ×10 000)=0.463816; the estimated p₊(80 000×80 000)=0.530308
Species 37: p₊(10 000×10 000)=0.0244648; q₊/₊(10 000
 ×10 000)=0.523148; the estimated p₊(80 000×80 000)=0.36979
Species 38: p₊(10 000×10 000)=0.0144168; q₊/₊(10 000
 ×10 000)=0.669192; the estimated p₊(80 000×80 000)=0.147025
Species 39: p₊(10 000×10 000)=0.00655308; q₊/₊(
 10 000×10 000)=0.3; the estimated p₊(80 000×80 000)=0.204982
Species 40: p₊(10 000×10 000)=0.08519; q₊/₊(10 000
 ×10 000)=0.295614; the estimated p₊(80 000×80 000)=0.965891
Species 41: p₊(10 000×10 000)=0.0506772; q₊/₊(10 000
 ×10 000)=0.189732; the estimated p₊(80 000×80 000)=0.915686
```

```
Export["C:\\Documents and Settings\\LOUBAR\\My
   Documents\\Dropbox\\NEC04455_STU_LouiseBarwell\\Downscaling
   Odonata code\\M_params\\Hui\\results_80km.dat",
 Table[{a[[1, j]], p[j - 2], q[j - 2], pp[j - 2]}, {j, 3, d2}], "TSV"]
```

```
C:\Documents and Settings\LOUBAR\My
  Documents\Dropbox\NEC04455_STU_LouiseBarwell\Downscaling
  Odonata code\M_params\Hui\results_80km.dat
```