Brown Trout Genetics – A Layman's Guide

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Brown trout population dynamics are very sensitive to the alterations of the physical and natural environment associated with anthropogenic impacts such as arterial drainage, cultural eutrophication, introduction of alien species and stocking of domesticated fishes; all of which may alter the demographic and ecological equilibria of these populations.

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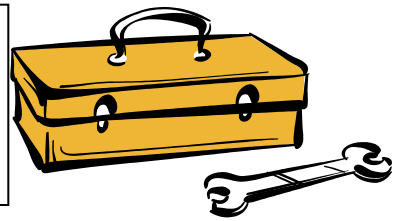
The Fishery Biologists Tool Box



Basic biology and ecology of fish.

Genetics ???

Monitoring water quality.

Baseline surveys Physical and Ecological

Management of Wild Brown Trout Stocks

Restoring fish production in physically damaged channels.

Quantification of Stocks and Monitoring.

Interactions with other fish species.

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History of IFI Brown Trout Genetic Studies

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Where it all started:

- IFI funded PhD on L. Corrib commenced in 2006, completed in 2009
- Involved IFI staff & local angling communities to collect samples
- UCD (PhD student et al.) to carryout lab work and data analyses

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Next		Commenced	Completed
L. Mask study	(funded by angling clubs & IFI)	2010	2010
Boyne & Suir study	(funded by OPW & IFI)	2010	2011
Ennell study	(funded by OPW & IFI)	2010	2011
Corrib (2nd study)	(funded by IFI & OPW)	2012	2014
Sheelin study	(funded by IFI, OPW & angling club)	2012	2014
Ramor study	(funded by angling club & IFI)	2013/2014	2017
Dublin Rivers	***(funded by IFI, QUB & OPW)***	***2014***	
Mid Shannon	***(funded by IFI, QUB & OPW)***	***2014***	
Moy Catchment	***(funded by IFI, QUB & OPW)***	***2014***	
L. Derg	(funded by EPA, QUB & IFI)	2006/7	2017
(2nd phase)		2012	2017
(3rd phase)		2016	2018

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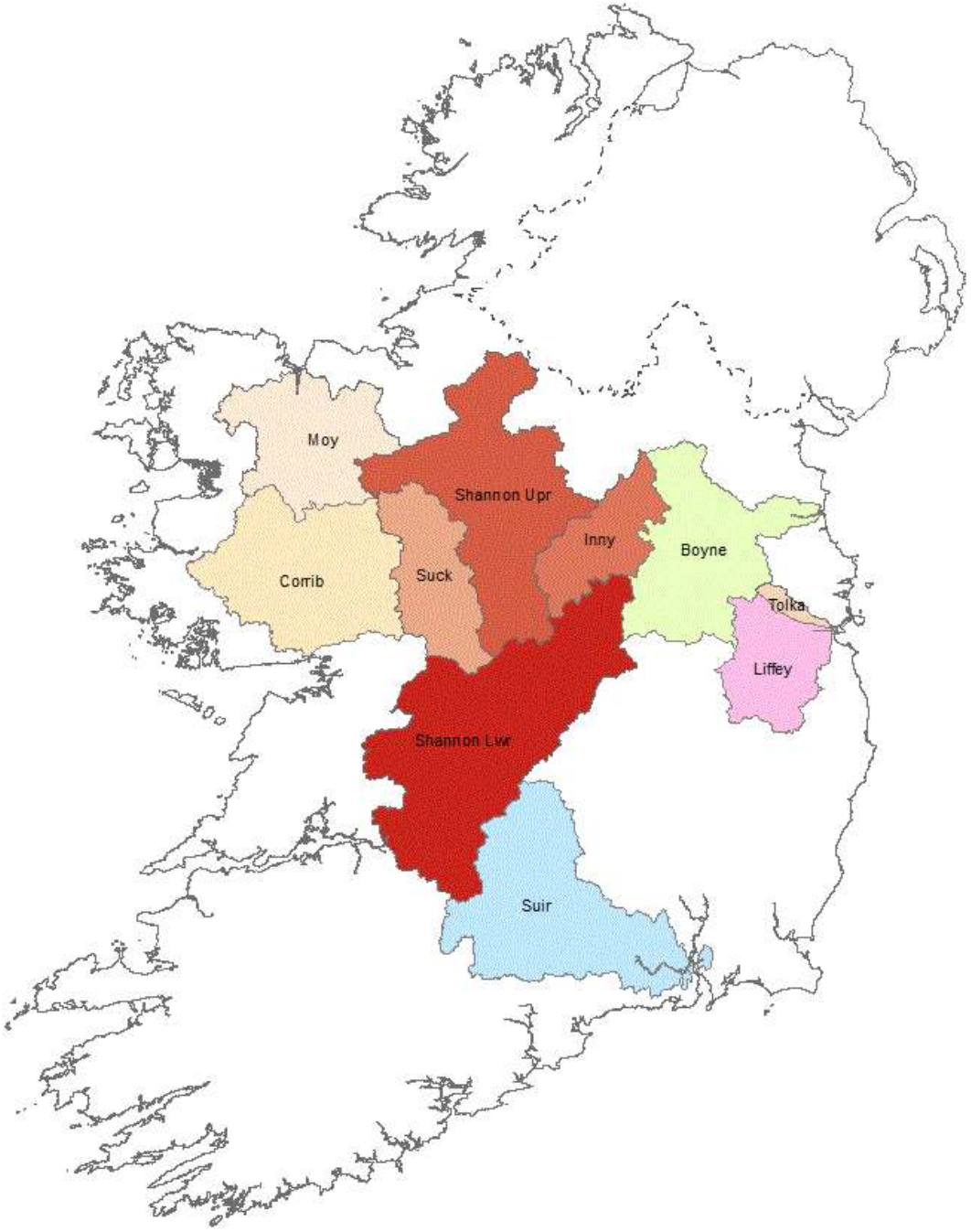

Catchment Name

- Boyne
- Corrib
- Liffey & Dodder
- Moy
- Inny
- Shannon Lwr
- Shannon Upr
- Suck
- Suir
- Tolka

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Objectives of all Genetic Studies

- Assess the genetic diversity of brown trout within a particular catchment
- To characterise and compare the level of genetic diversity and pattern of spatial structure in brown trout populations in Irish catchments.
- To estimate the proportional contribution of each tributary sub-catchment to the mixed fishery of either its the main channel or lake system
- To investigate if there are a number of distinct genetic groups in each catchment
- If there are distinct groups, understand how important each group is to the fishery. Estimate the contribution of various tributary streams to the adult population either the lake or main river channel (eg where do fish go when they leave the spawning and nursery areas, do they stay in the same stream/river/channel or do they move into a larger river / lake - where do the trout the anglers catch in a lake or river come from?

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Objectives of all Genetic Studies

- To assess the impact of various pressures (drainage, chronic pollutions, fish kills, afforestation) on the genetics of the brown trout in each catchment Consider what will happen if the key contributors fail - ie suffer serious pollution incidents leading to major fish kill, undergo high impact alteration – landslide, drainage etc
- To assess the impact of stocking on the wild brown trout population in selected catchments (eg has there been any interbreeding between wild stock and the introduced hatchery trout, has the stocking done any harm or has it been of benefit
- To help determine where to invest limited resources in terms of instream development,
- Role in planning applications - if development is on a system that has a unique genetic signature

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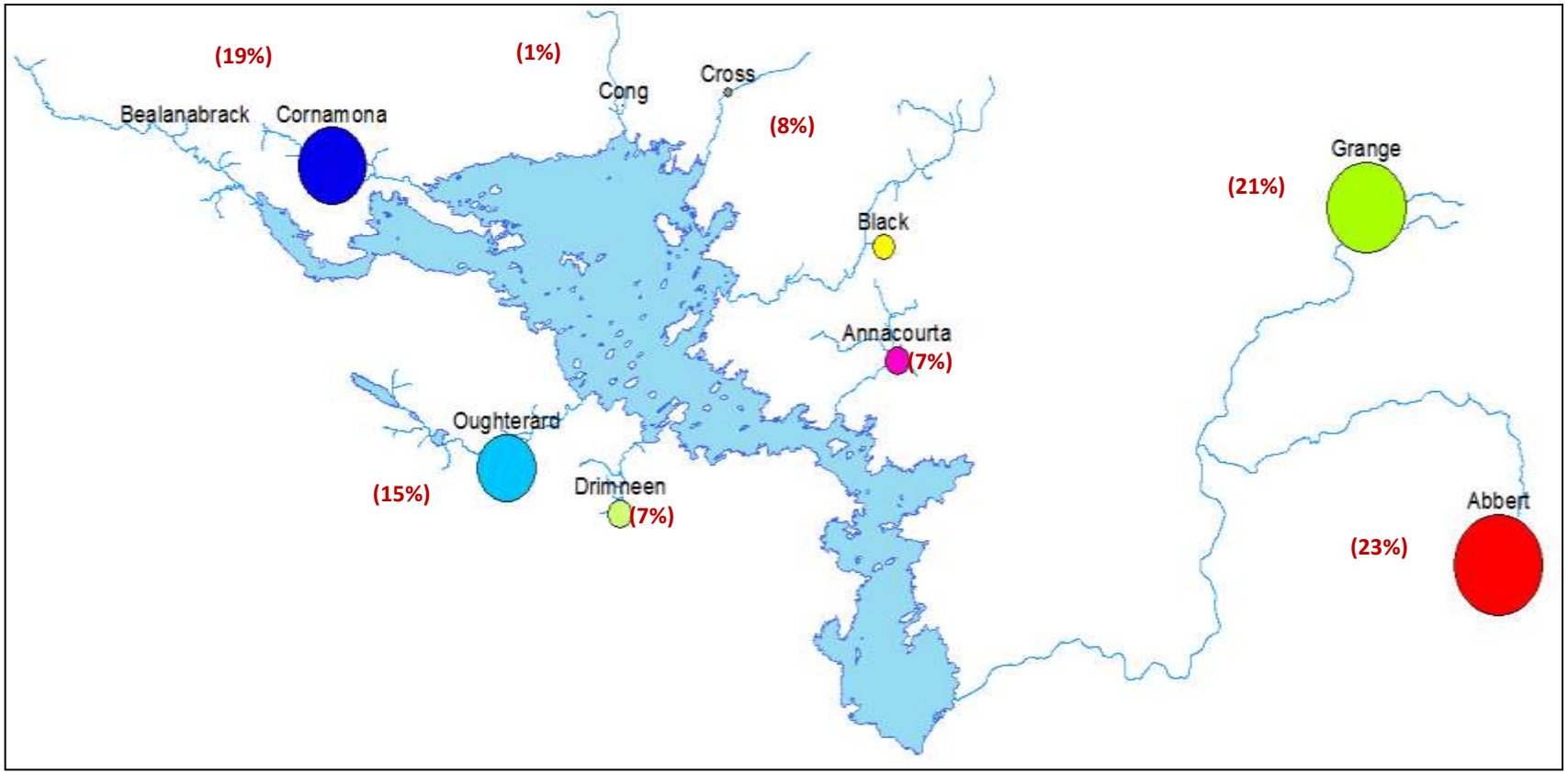
% Contribution from individual sub-catchments.



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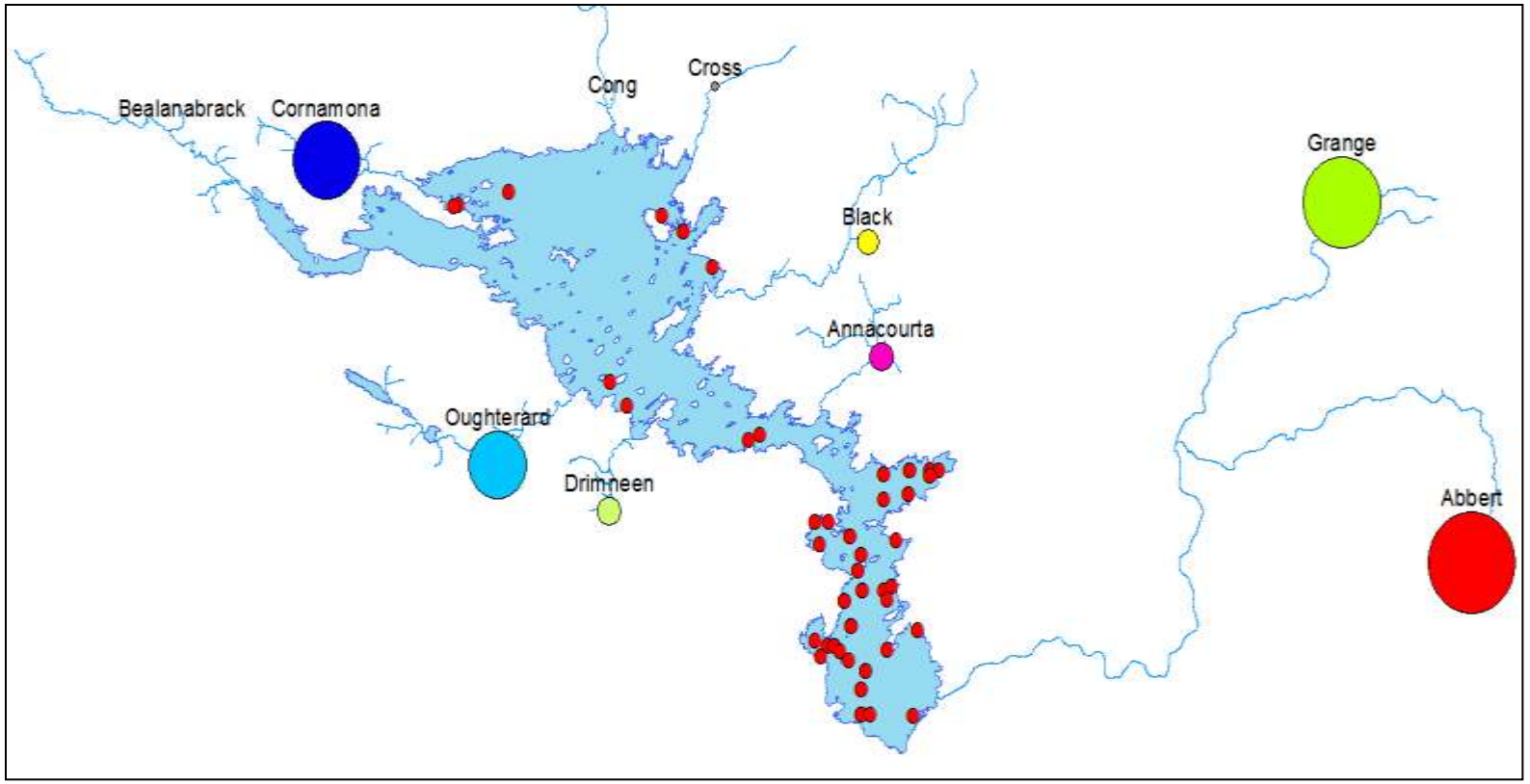
Distribution of fish in the lake from the different sub-catchments



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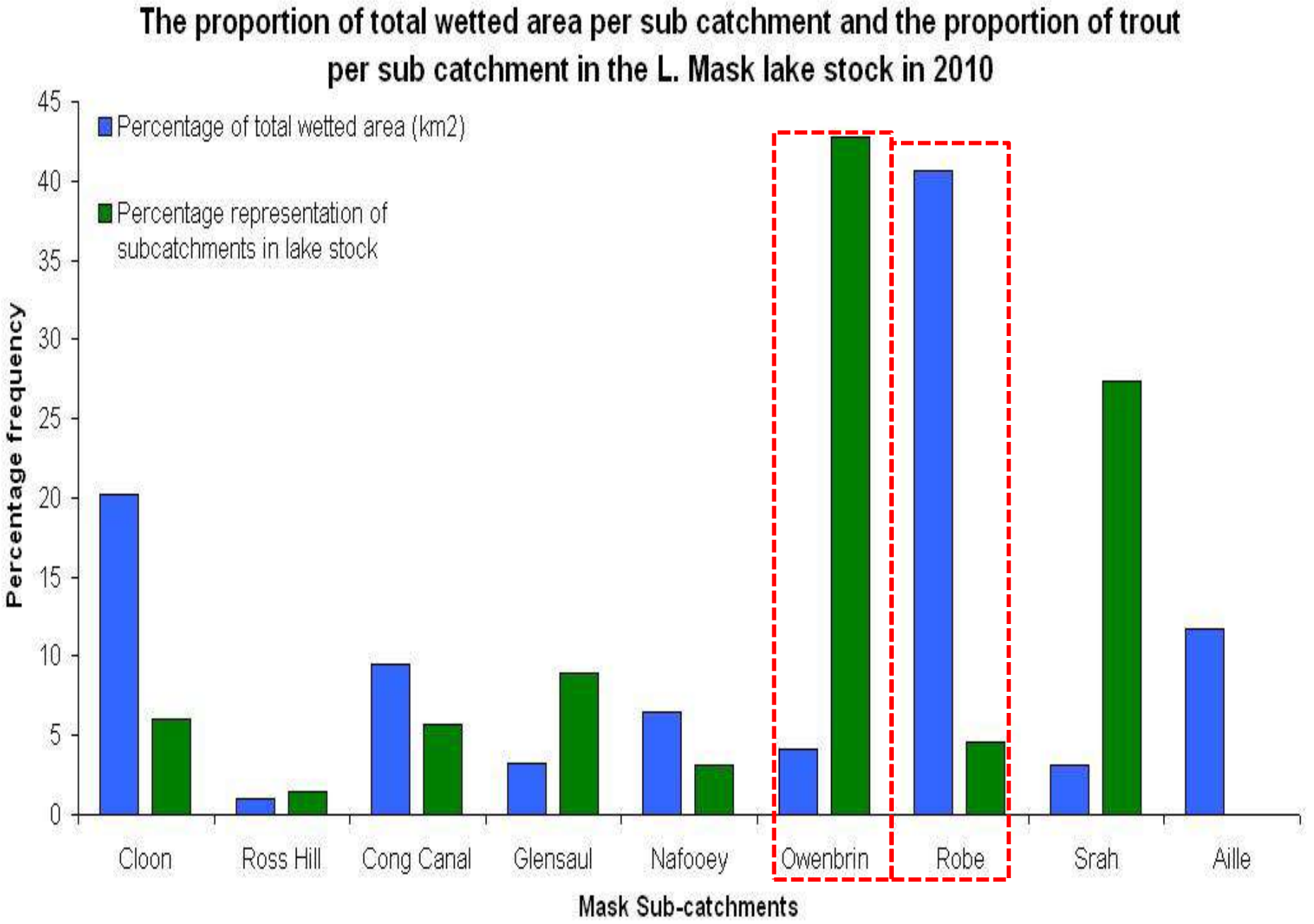
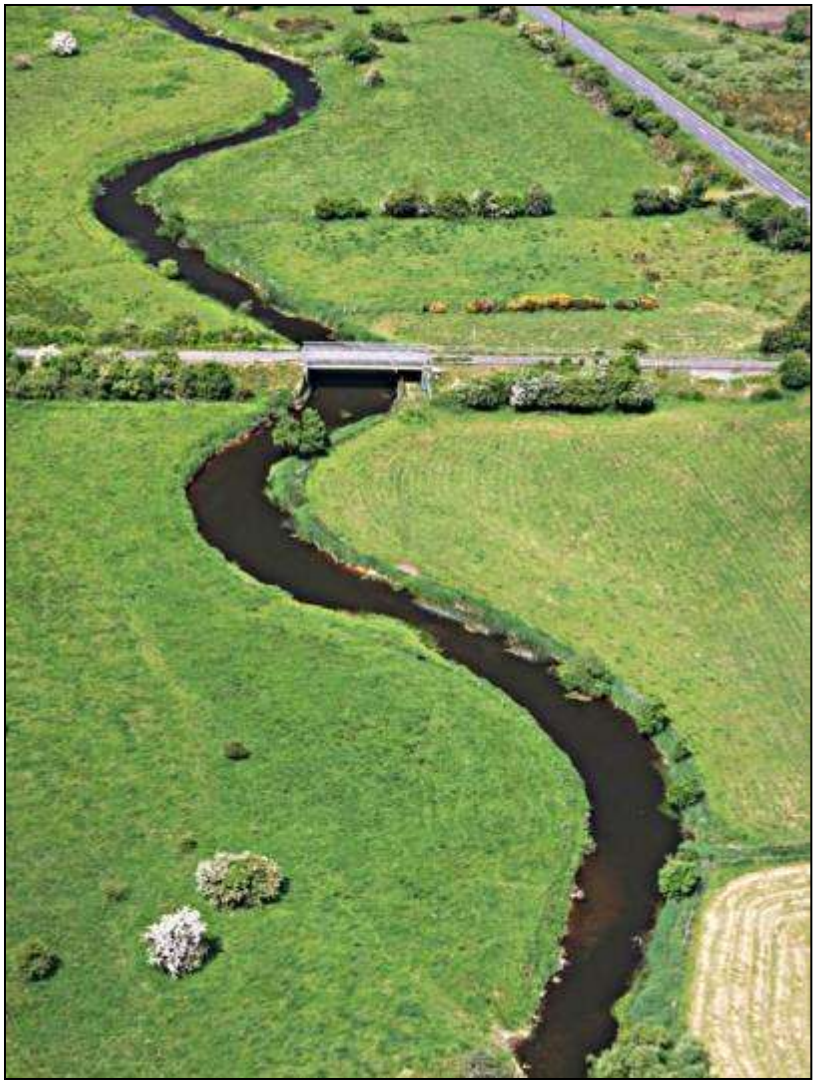

The proportion of total wetted area per sub catchment and the proportion of trout per sub catchment in the L. Mask lake stock in 2010
Percentage of total wetted area (km2)
Percentage representation of subcatchments in lake stock
Percentage frequency
45
40
35
30
25
20
15
10
5
0
Cloon
Ross Hill
Cong Canal
Glensaul
Nafooey
Owenbrin
Robe
Srah
Aille
Mask Sub-catchments

Owenbrin R.



Robe R.

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Lough Mask Catchment

The dangers of forestry harvesting on the Owenbrin River.

----- over 42% of the adult trout in L. Mask are of Owenbrin origin!!

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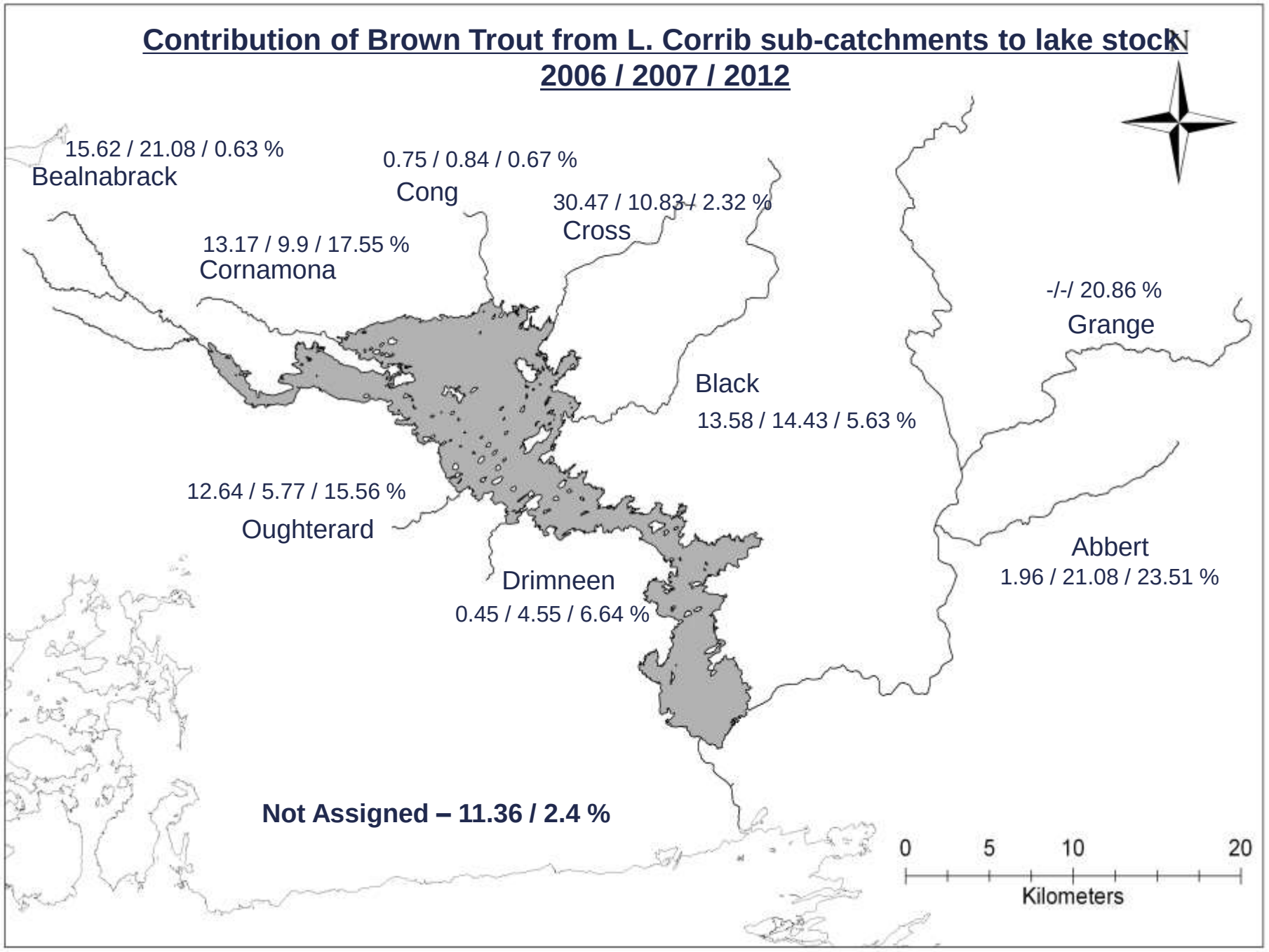
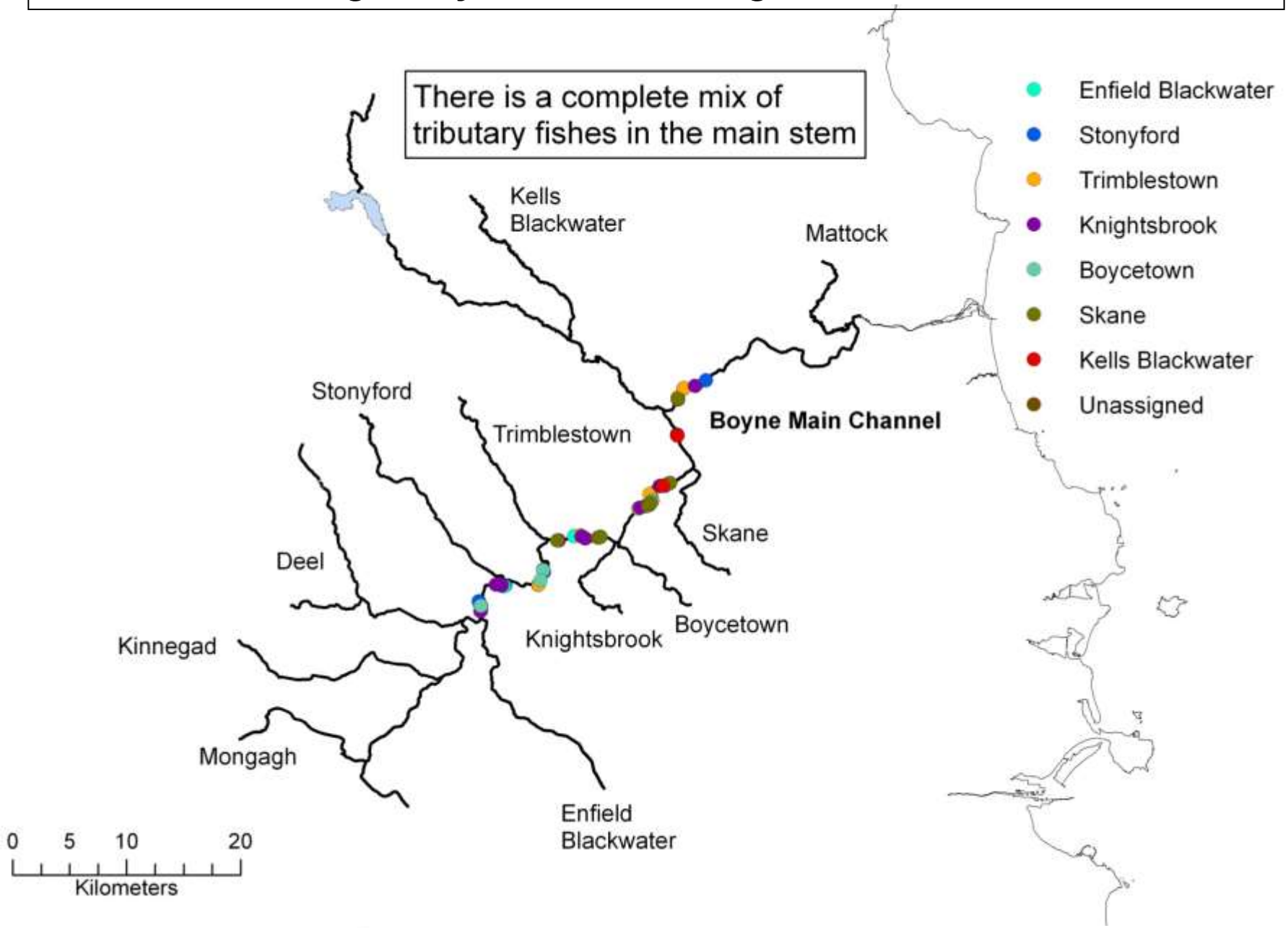

Contribution of Brown Trout from L. Corrib sub-catchments to lake stock
2006 / 2007 / 2012
N
15.62 / 21.08 / 0.63 %
Bealnabrack
0.75 / 0.84 / 0.67 %
Cong
30.47 / 10.83 / 2.32 %
Cross
13.17 / 9.9 / 17.55 %
Cornamona
-/-/ 20.86 %
Grange
Black
13.58 / 14.43 / 5.63 %
12.64 / 5.77 / 15.56 %
Oughterard
Abbert
1.96 / 21.08 / 23.51 %
Drimneen
0.45 / 4.55 / 6.64 %
Not Assigned – 11.36 / 2.4 %
0
5
10
20
Kilometers

How are the migratory stocks to a large river or lake distributed?



Use of Citizen Science – How and Why

Citizen Science is on the increase and we commonly hear of projects that involve 'citizen science'

- Bird Watch Ireland
- National Biological Data Centre
- LAWCO
- IFI Lamprey project (*spot the lamprey*)

So not a new idea.

Why use it

- limited resources of the agency (staff and funding)
- citizens there anywhere so greater spatial coverage
- only involve when doesn't involve specialist equipment and is easy to take/record
- citizens interested and willing to engage especially when it is in their own area / or the activity they are interested in.

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Process for the current Brown Trout Project;

- anglers were the targeted citizen scientists
- given instruction card, scale envelopes, initially plastic knives
- asked to record, length and gps/location, additional useful info sometimes recorded such as weight
- Scale samples sent back to either regional office or directly to HQ / Martin O'Grady
- Entered to database
- Samples sent to QUB

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Did Citizen Science Work?

- For the most part YES

- Improvements - Both for IFI and Citizen Scientists
    - Better co-ordination of sample collection and database
    - Provide workshop to own staff as well as interested groups/citizen scientists
    - Better recording of details by anglers in relation to locations and standardise units for recording lengths, weights etc
    - Would have reduced the number of samples that had to be excluded from database & analysis

Even so project was very successful and we are Most Grateful to all those clubs and anglers who provided scale samples and funding to the project

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Fisheries and Genetics

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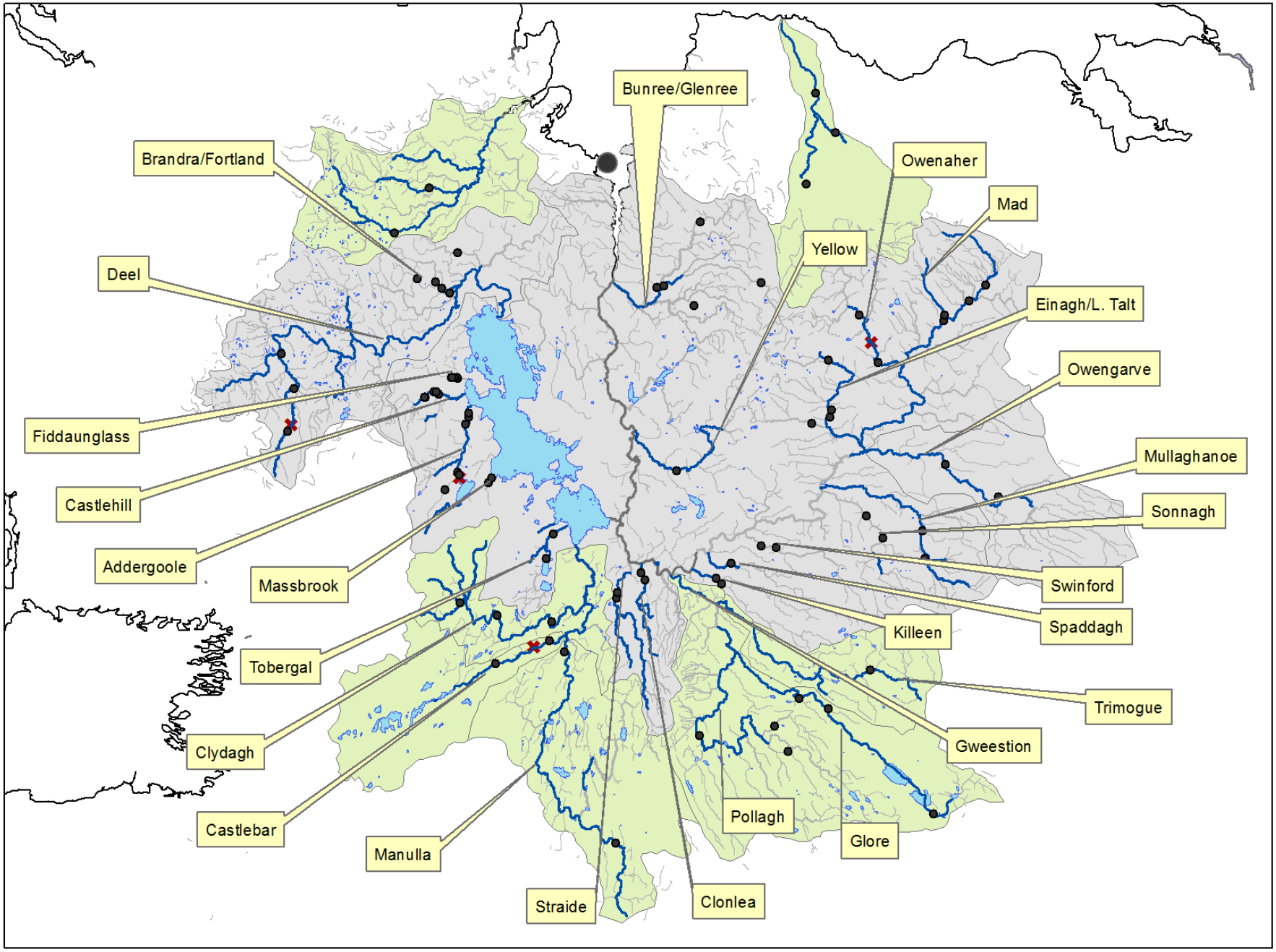
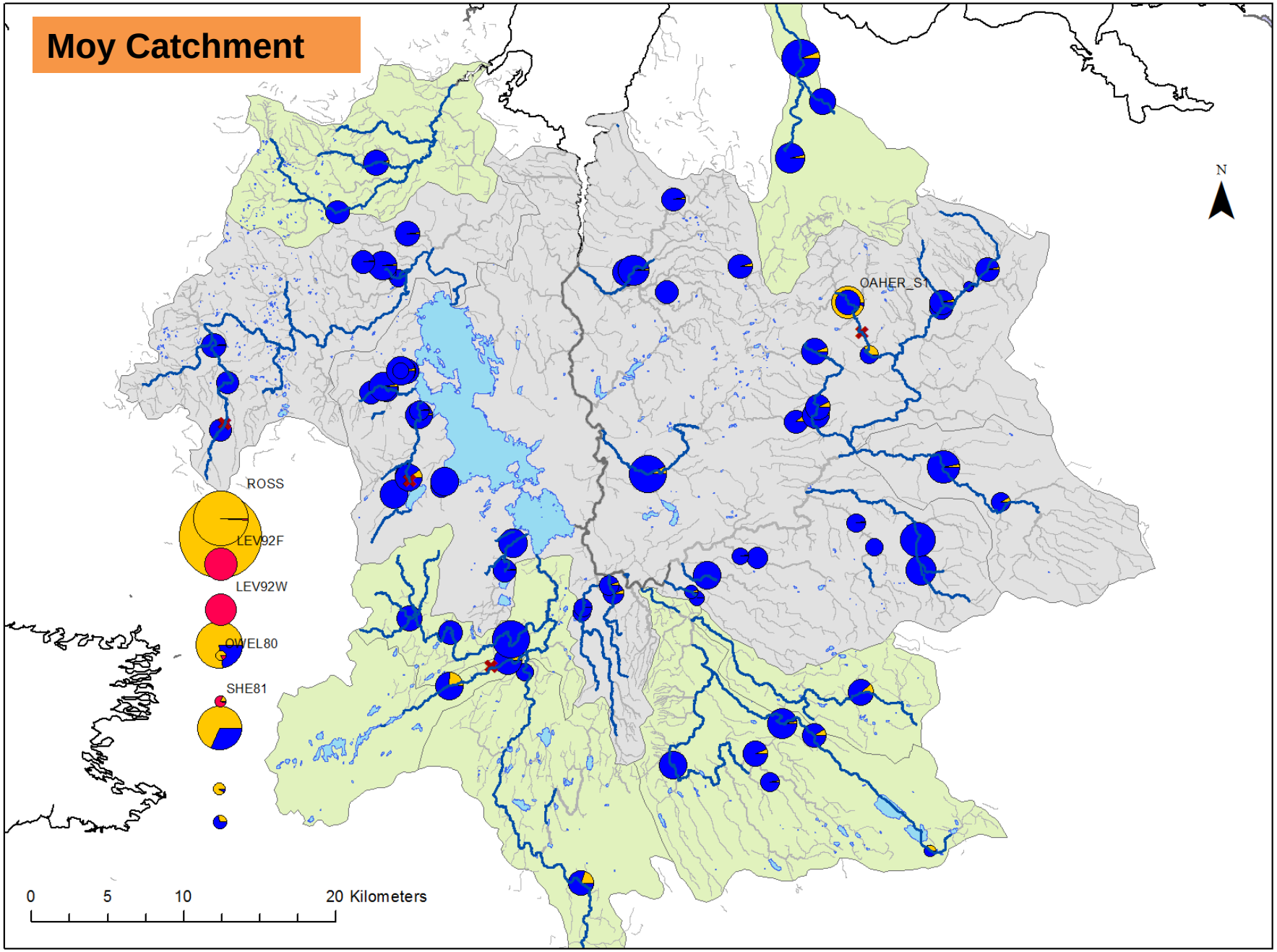
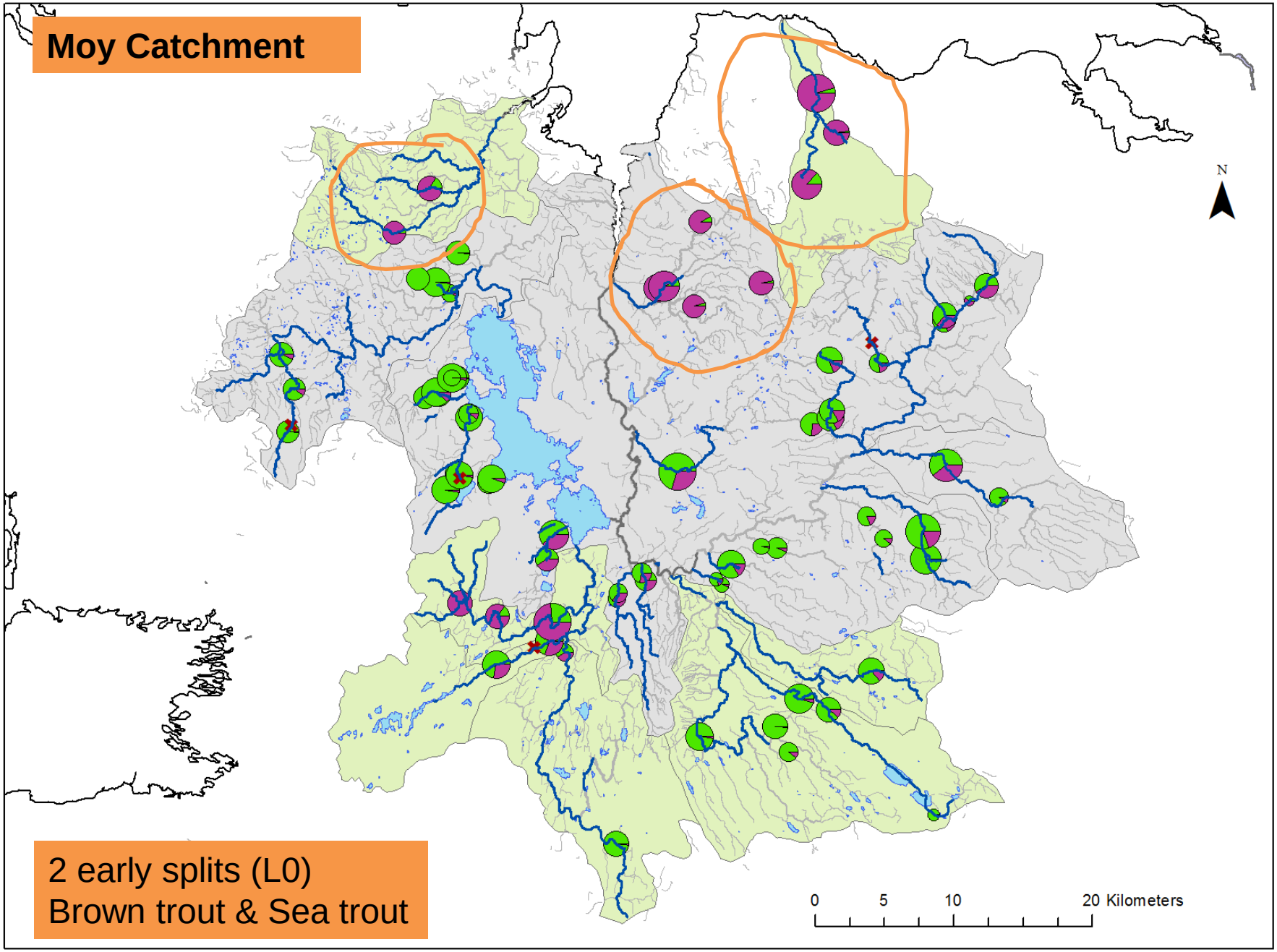
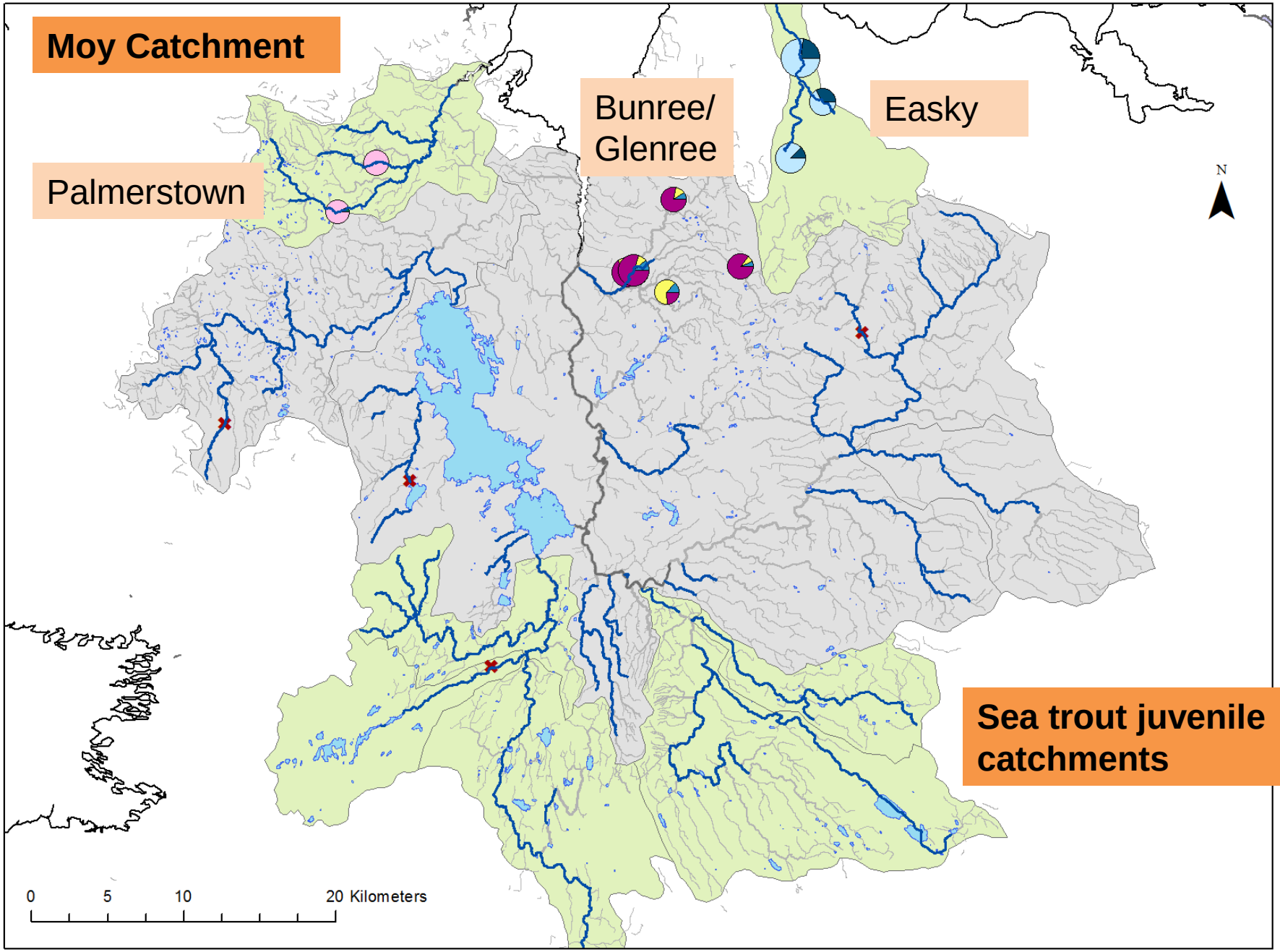
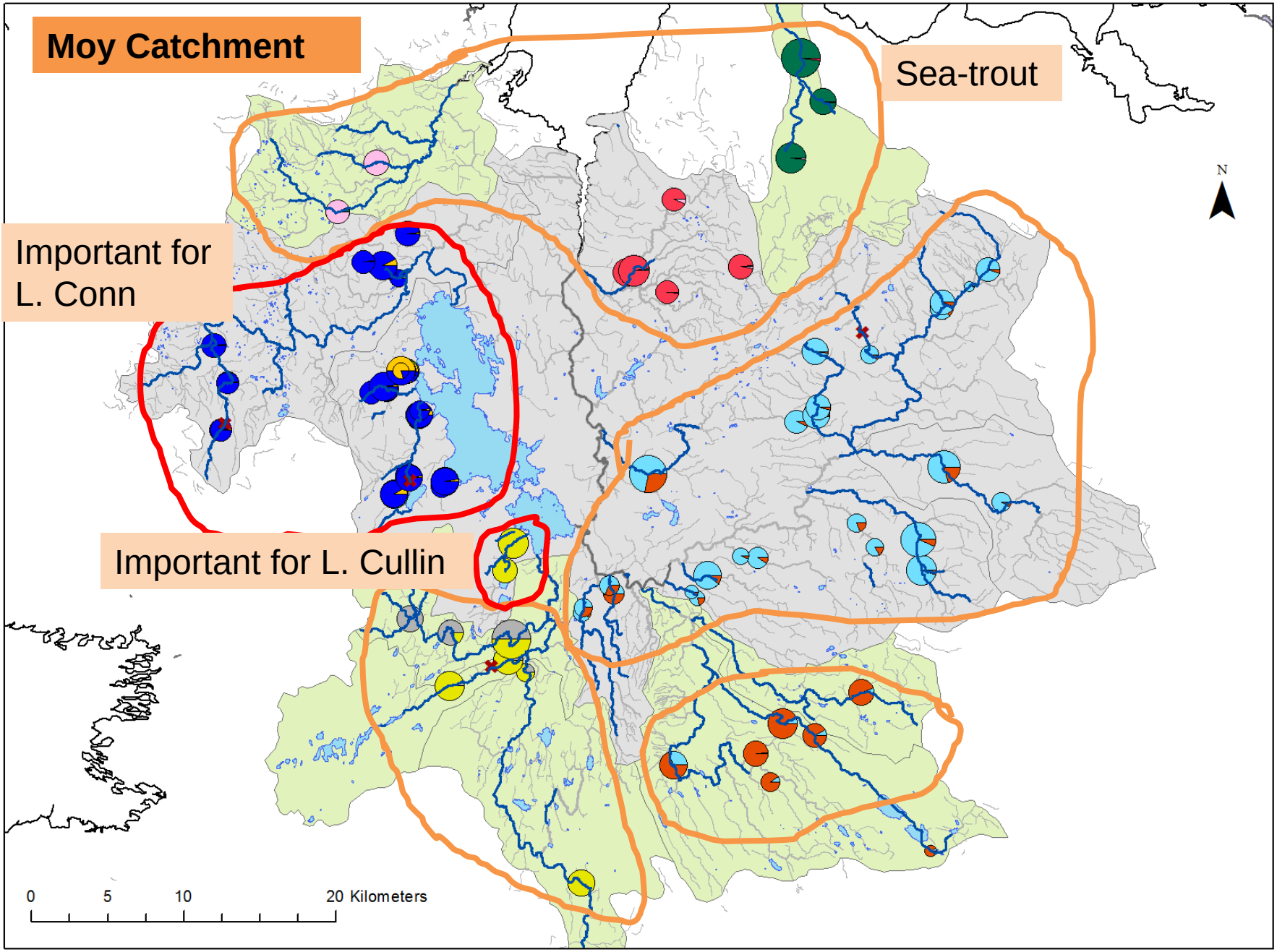
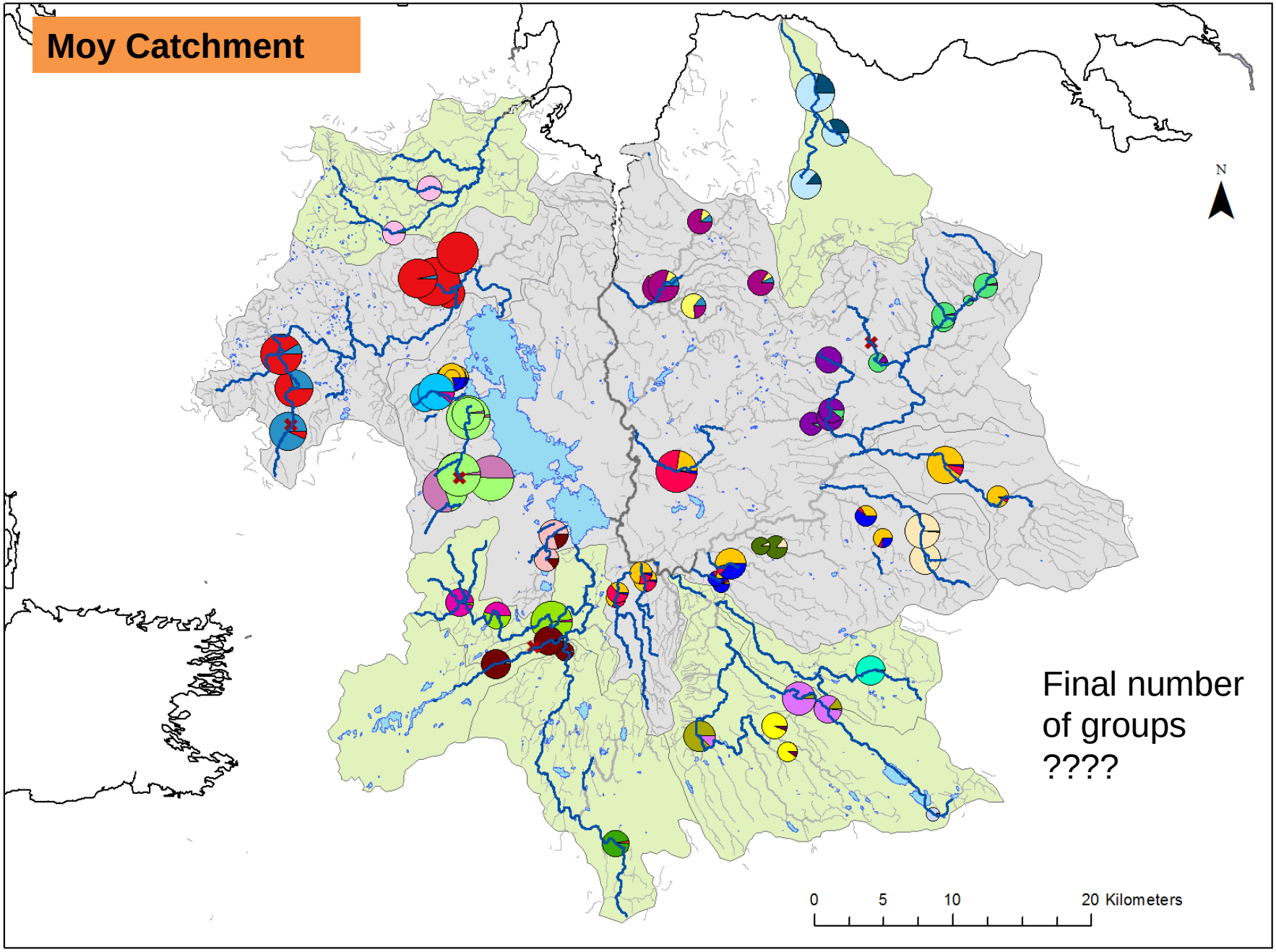

Bunree/Glenree
Brandra/Fortland
Owenaher
Mad
Yellow
Deel
Einagh/L. Talt
Owengarve
Fiddaunglass
Mullaghanoe
Castlehill
Sonnagh
Addergoole
Massbrook
Swinford
Spaddagh
Killeen
Tobergal
Trimogue
Gweestion
Clydagh
Castlebar
Pollagh
Glore
Manulla
Straide
Clonlea

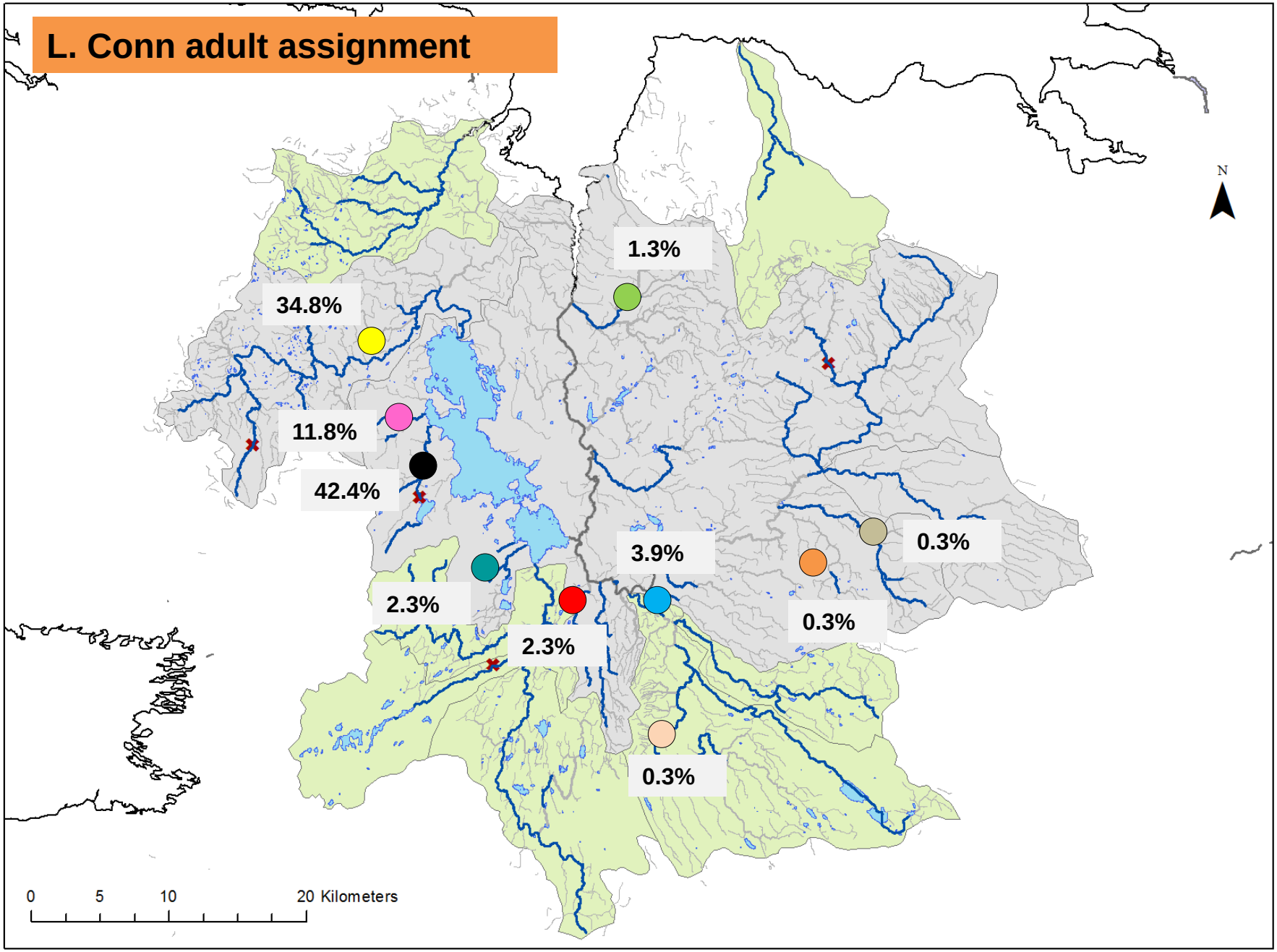

Moy Catchment
N
OAHER_S1
ROSS
LEV92F
LEV92W
OWEL80
SHE81
0
5
10
20 Kilometers

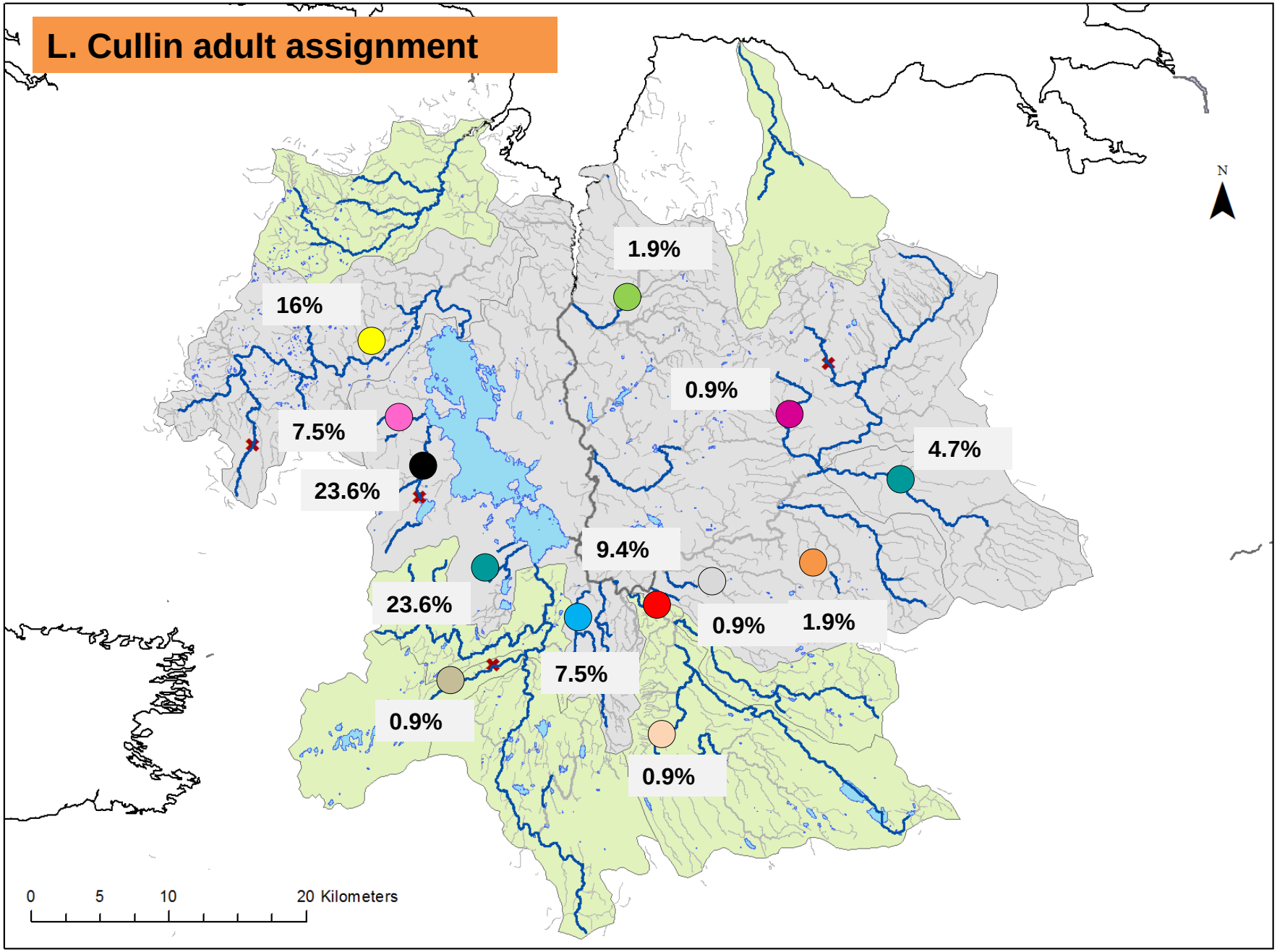

Moy Catchment
N
0
5
10
20 Kilometers
2 early splits (L0)
Brown trout & Sea trout

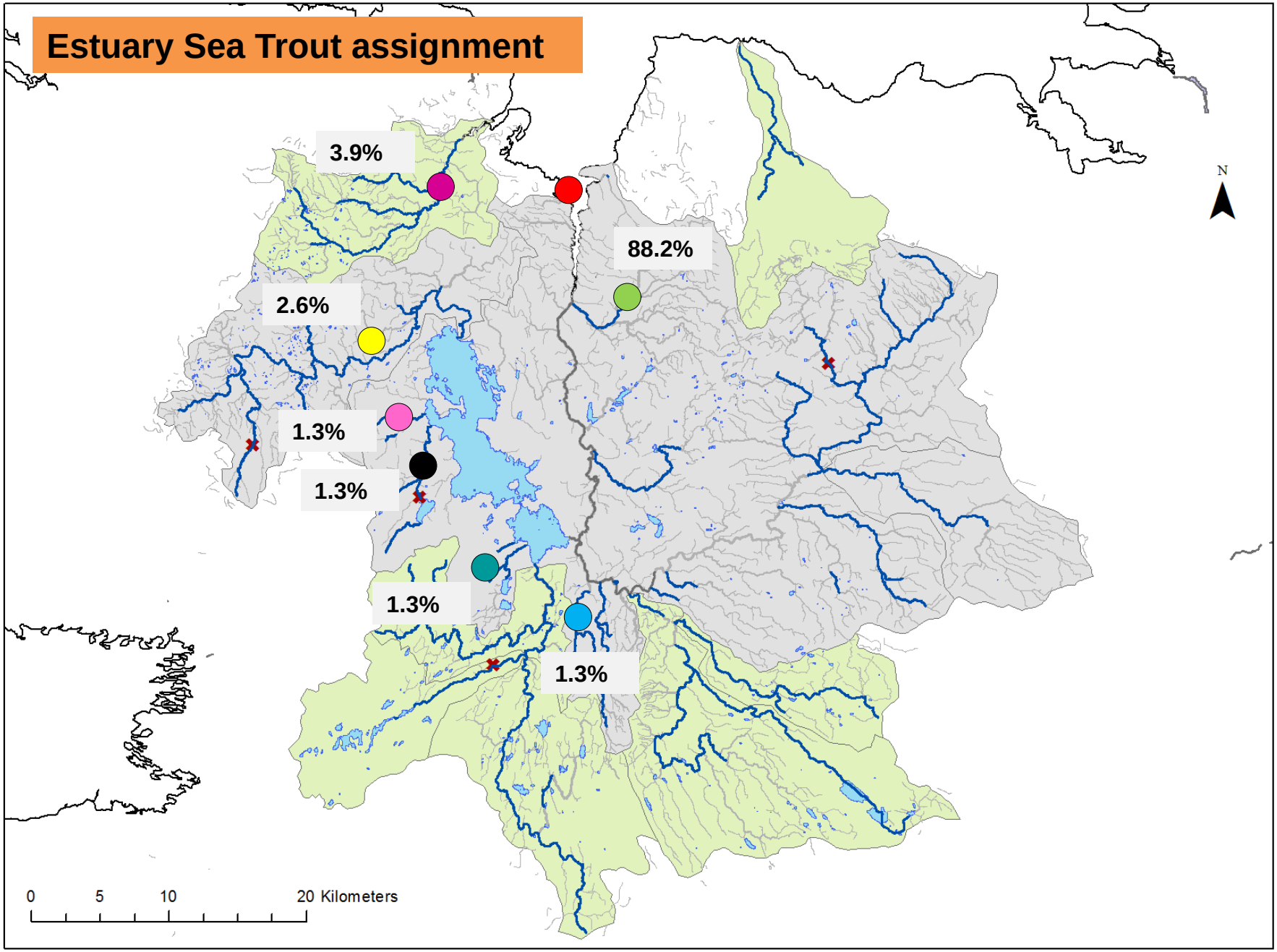

Moy Catchment
Palmerstown
Bunree/
Glenree
Easky
N
Sea trout juvenile
catchments
0
5
10
20 Kilometers


Moy Catchment
Sea-trout
Important for L. Conn
Important for L. Cullin
N
0
5
10
20 Kilometers


Moy Catchment
N
Final number of groups ????
0
5
10
20 Kilometers


L. Conn adult assignment
1.3%
34.8%
11.8%
42.4%
3.9%
0.3%
2.3%
0.3%
2.3%
0.3%
N
0
5
10
20 Kilometers


L. Cullin adult assignment
N
1.9%
16%
0.9%
7.5%
4.7%
23.6%
9.4%
23.6%
0.9%
1.9%
7.5%
0.9%
0.9%
0
5
10
20 Kilometers


Estuary Sea Trout assignment
3.9%
88.2%
2.6%
1.3%
1.3%
1.3%
1.3%
N
0
5
10
20 Kilometers

Inferred Structure baseline	Lough Conn	Lough Cullin	Moy Estuary
Upper_Deel	29 (9.5%)	9 (8.5%)	1 (1.3%)
Deel_Brandra_Fortland	**77 (25.3%)**	8 (7.5%)	1 (1.3%)
Castlehill	36 (11.8%)	8 (7.5%)	1 (1.3%)
Addergoole_Massbrook	**129 (42.4%)**	**25 (23.6%)**	1 (1.3%)
Tobergall	7 (2.3%)	**25 (23.6%)**	1 (1.3%)
Clydagh	-	1 (0.9%)	-
Clonlea_Straide	7 (2.3%)	8 (7.5%)	1 (1.3%)
Killeen_Spaddagh	12 (3.9%)	10 (9.4%)	-
Swinford	-	1 (0.9%)	-
Pollagh	1 (0.3%)	1 (0.9%)	-
Sonnagh	1 (0.3%)	2 (1.9%)	-
Einagh	-	1 (0.9%)	-
Mullaghanoe	1 (0.3%)	-	-
Owengarve	-	5 (4.7%)	-
Palmerstown	-	-	3 (3.9%)
Bunree_Glenree	4 (1.3%)	2 (1.9%)	**67 (88.2%)**
Grand Total	410(100%)	106 (100%)	76(100%)

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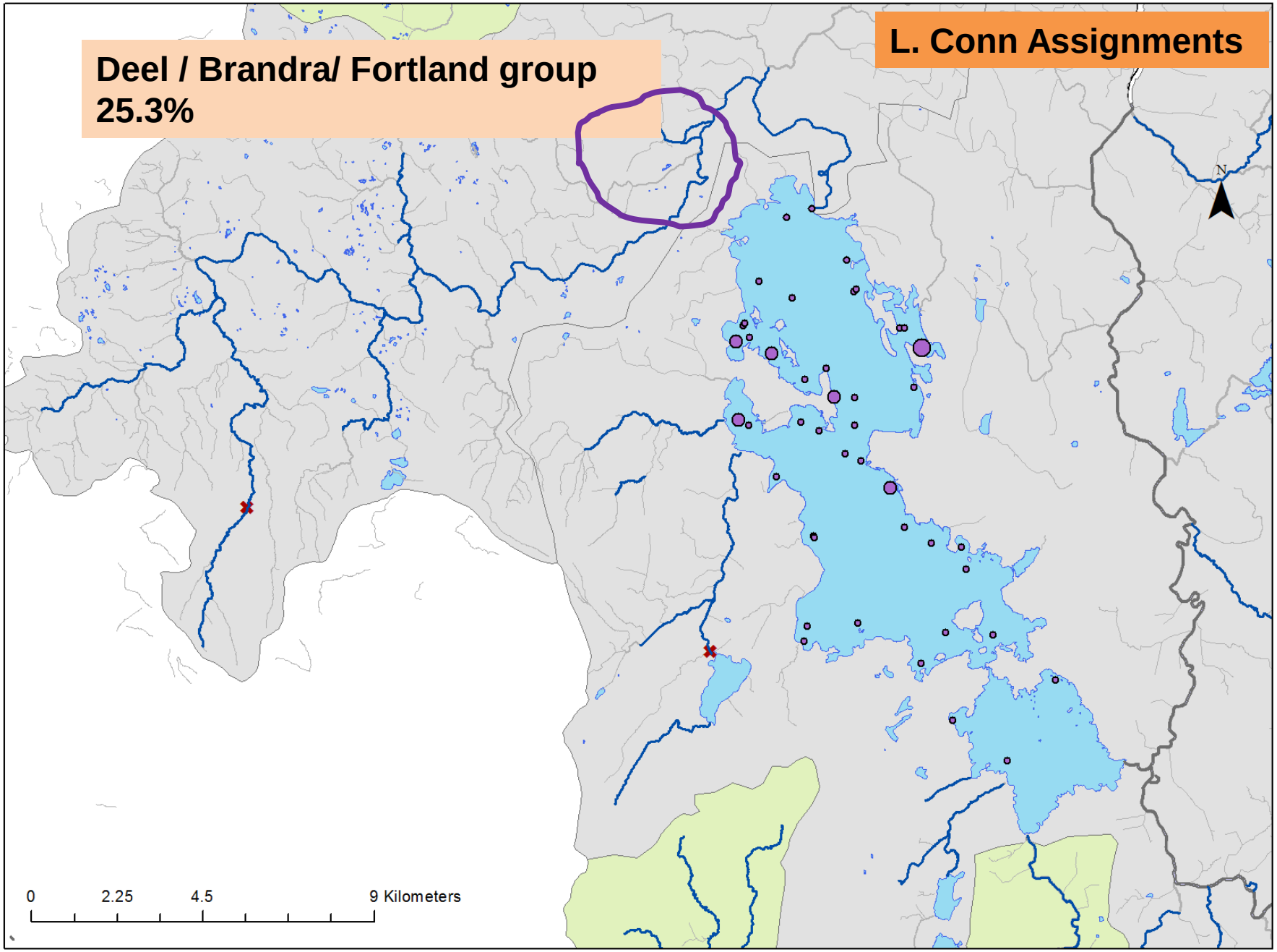
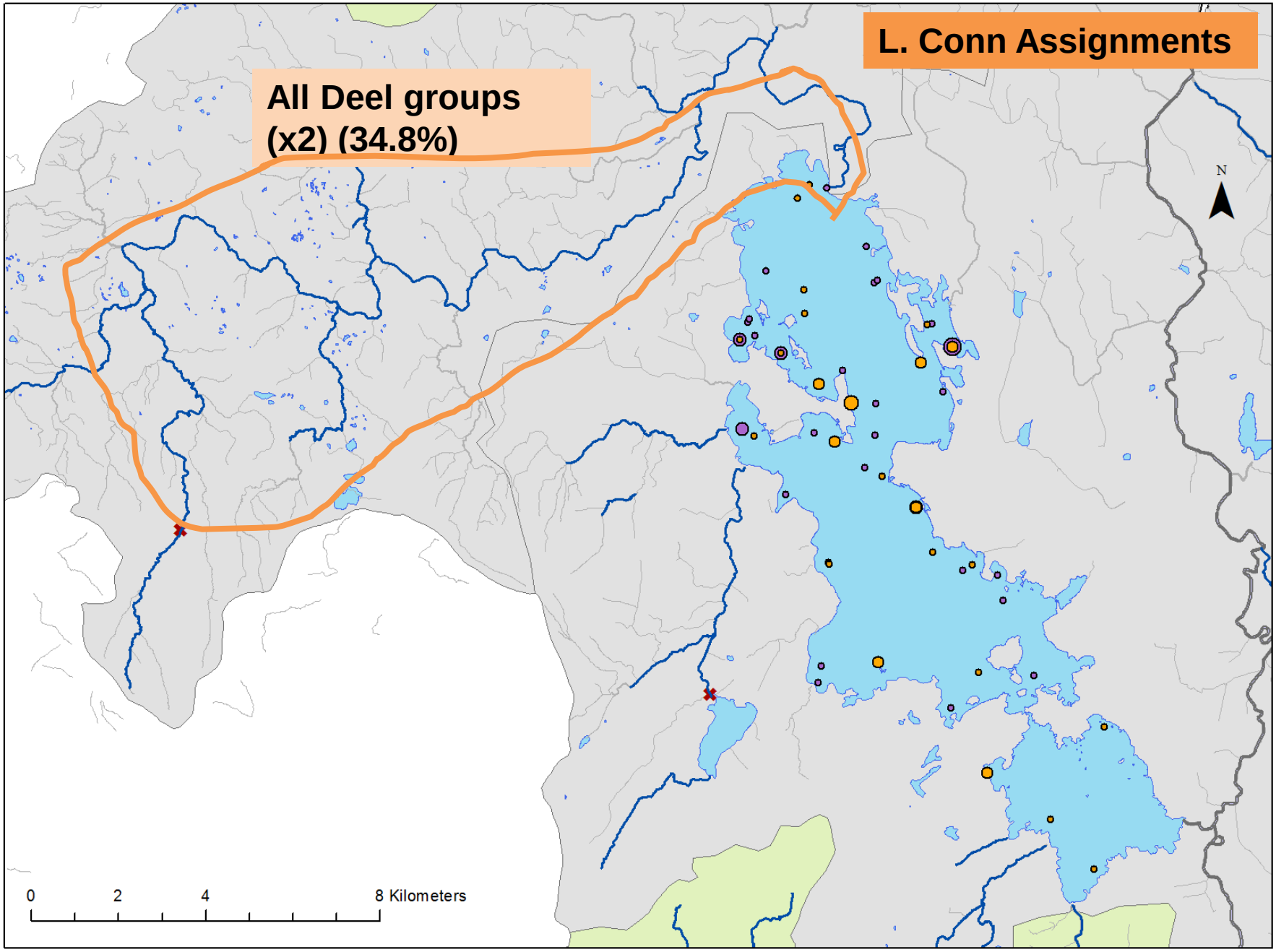
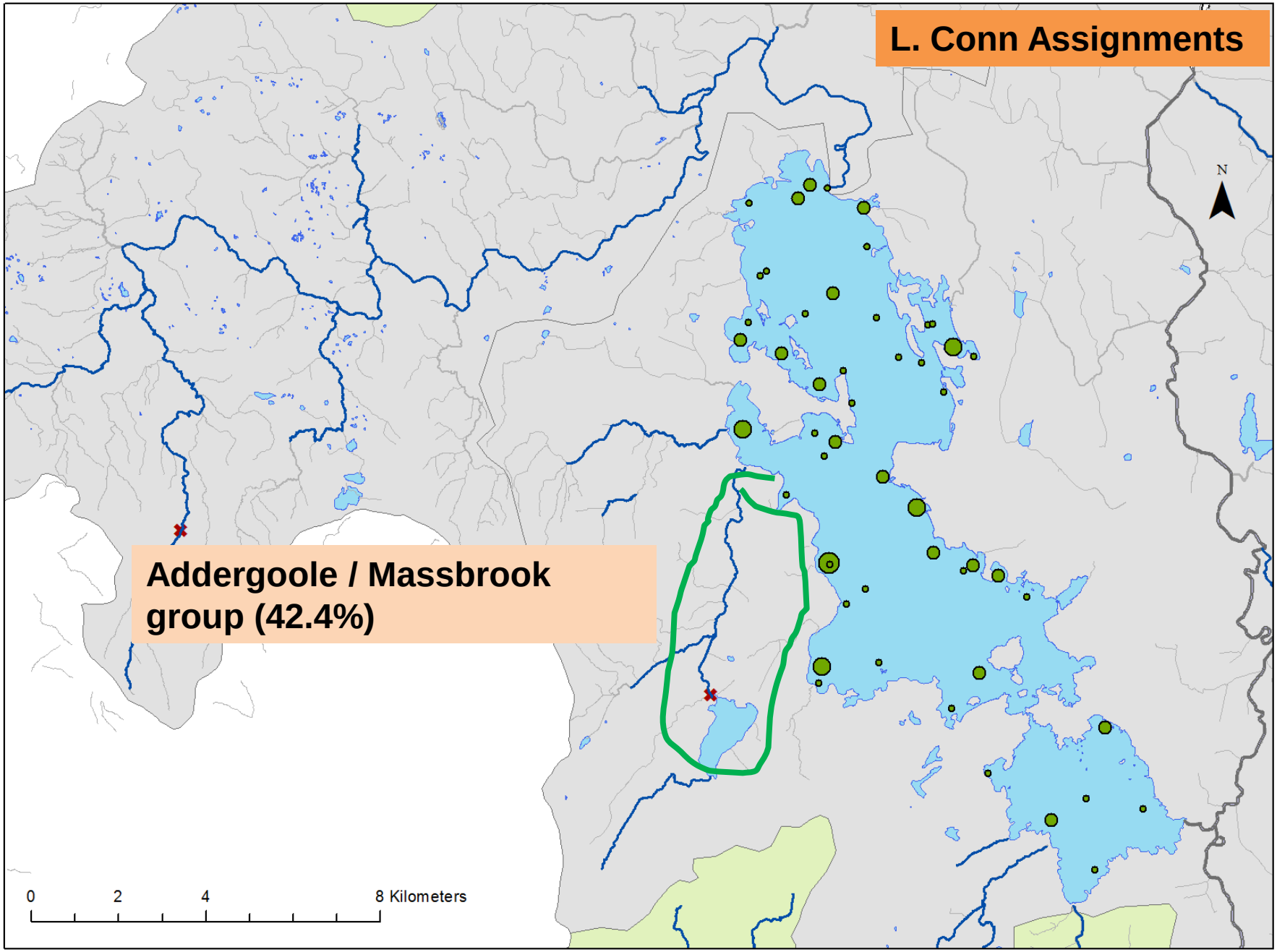
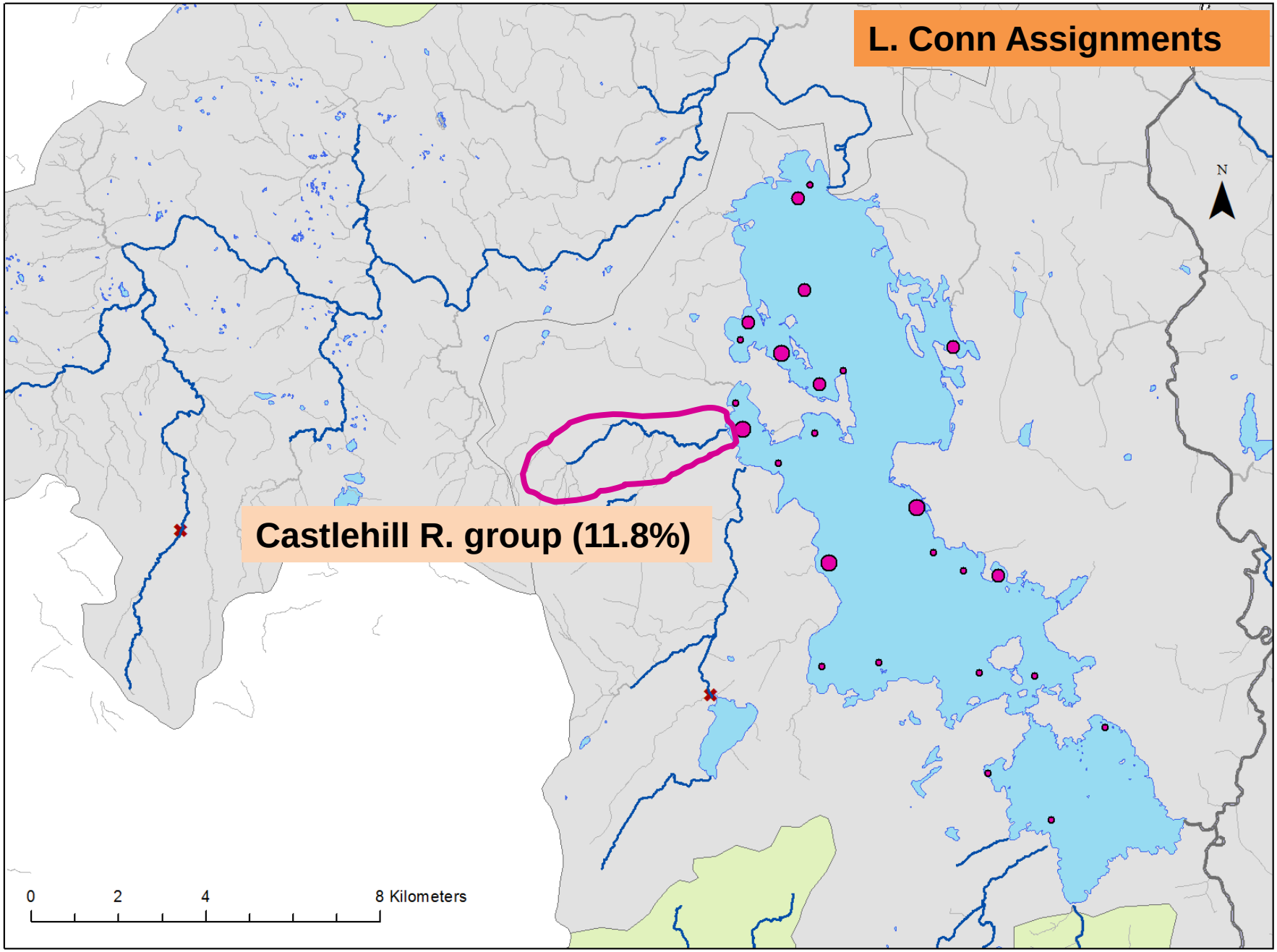
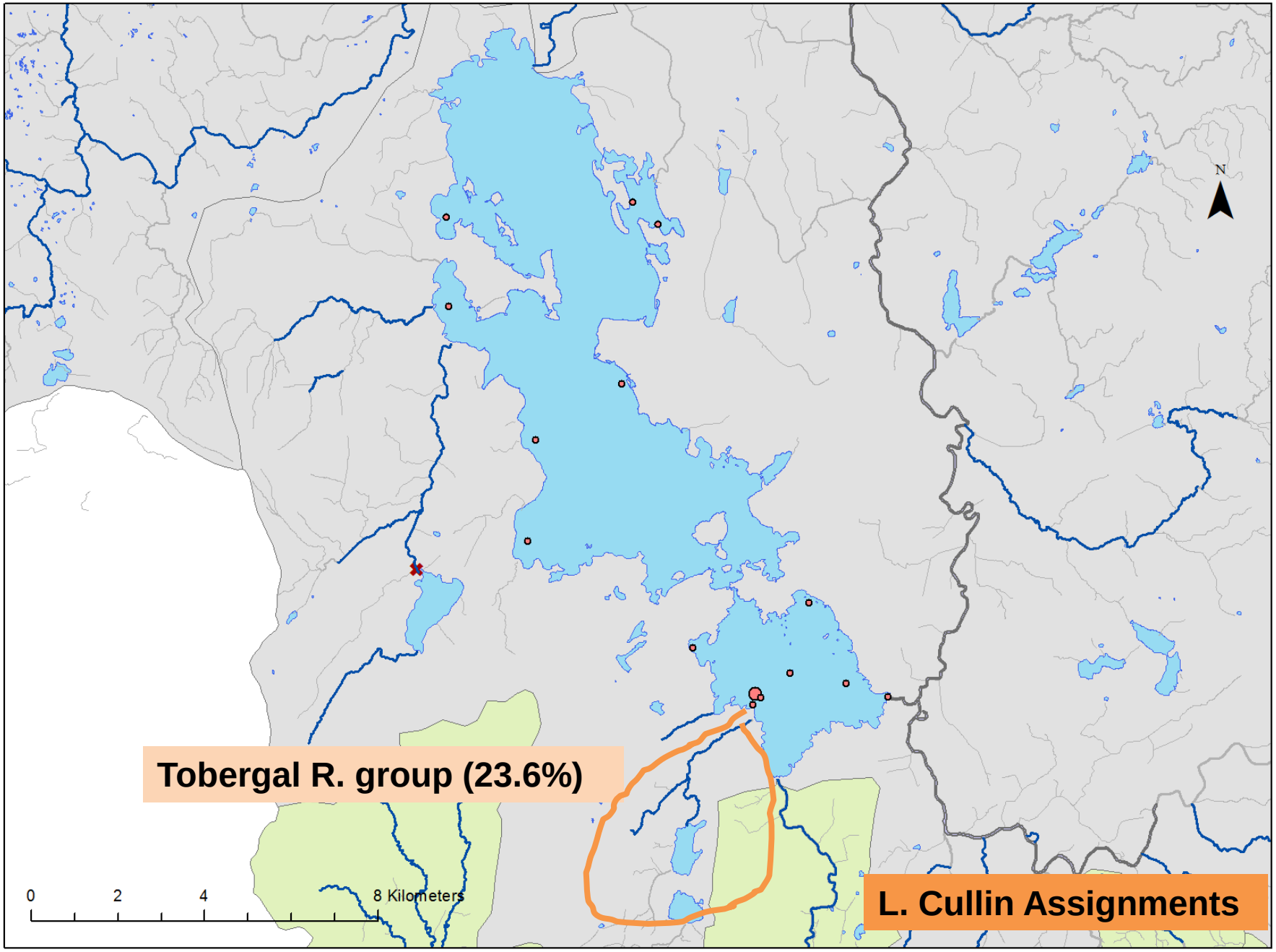
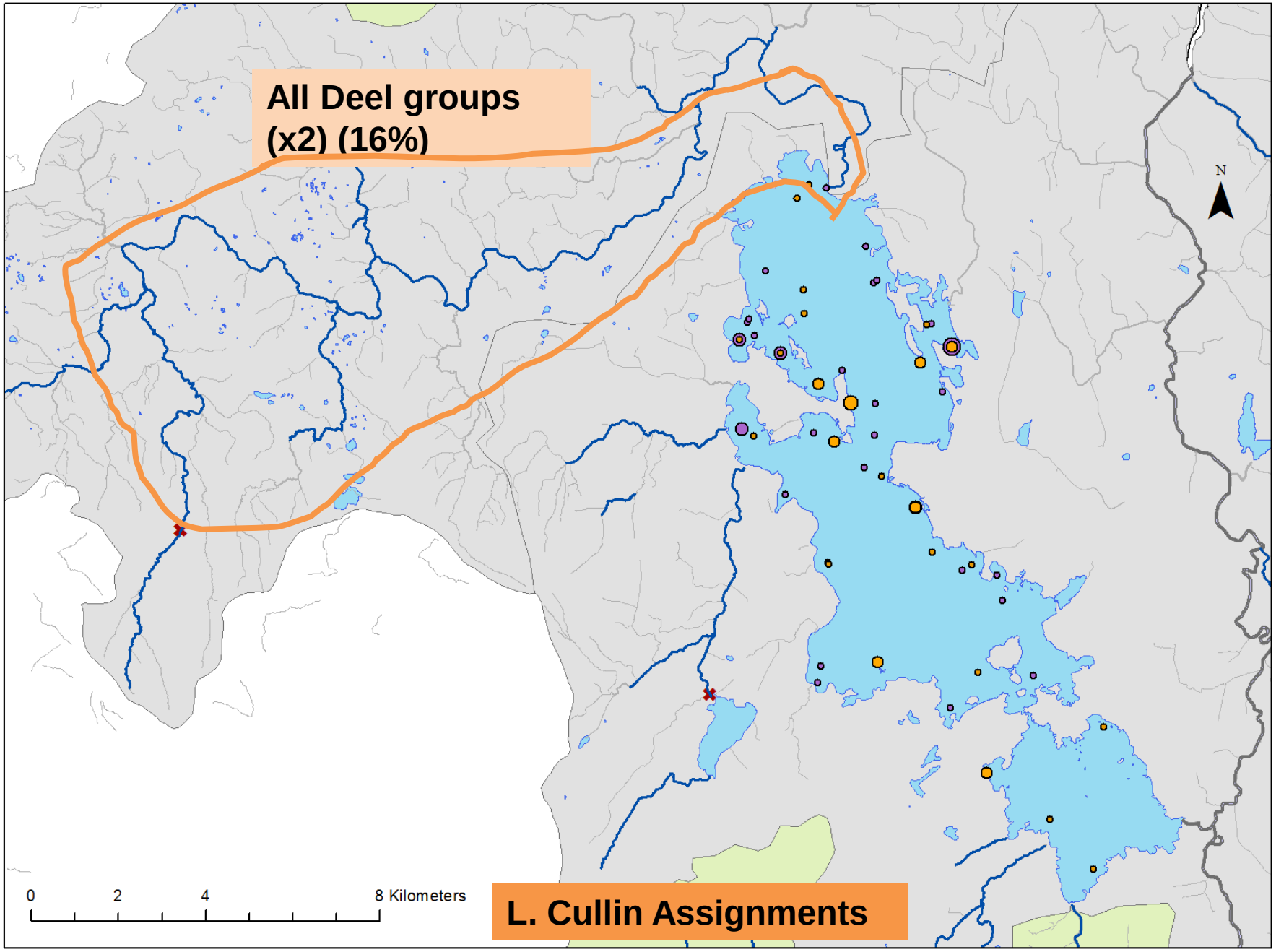

Deel / Brandra/ Fortland group
25.3%
L. Conn Assignments
N
0
2.25
4.5
9 Kilometers

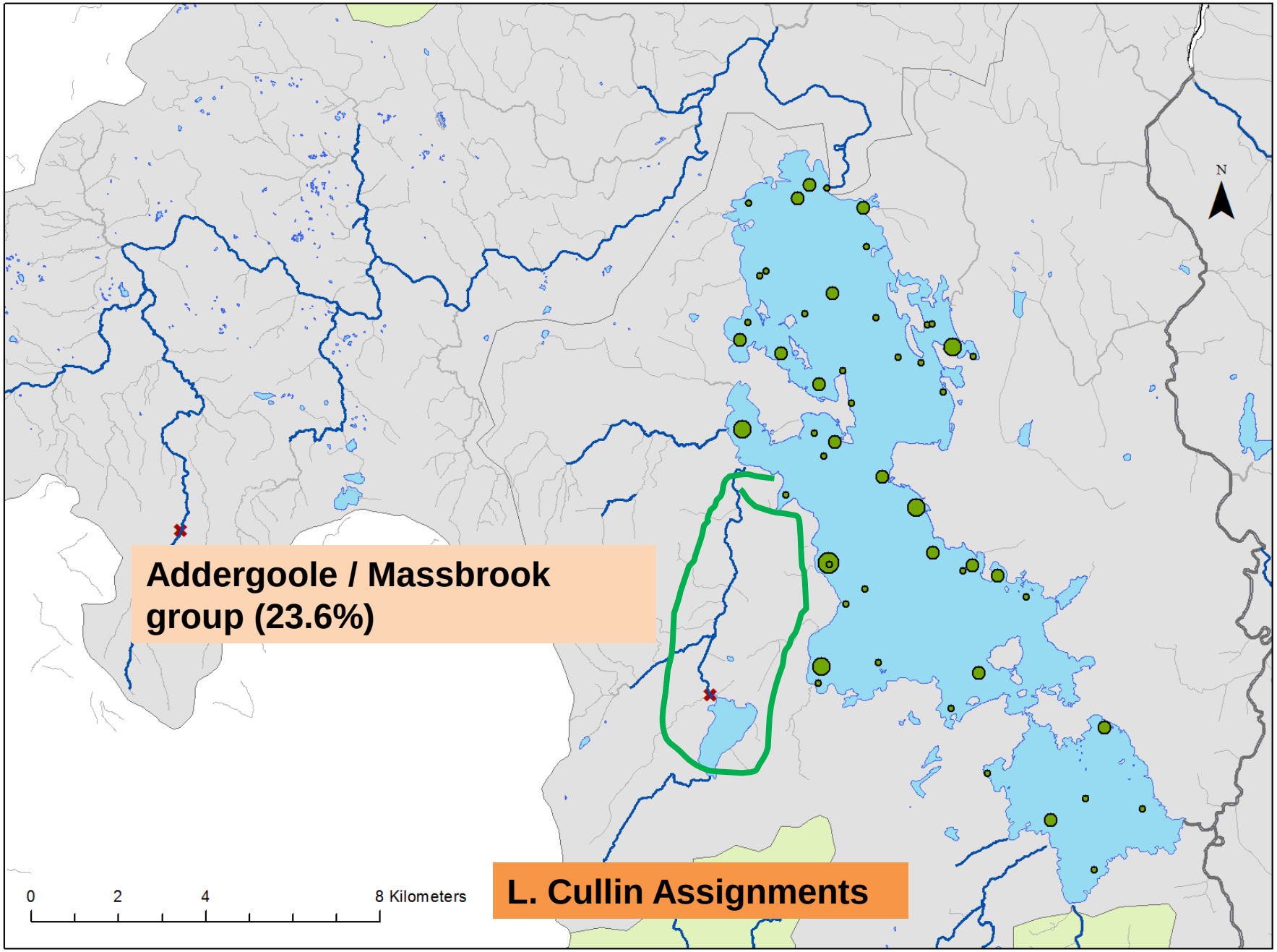

L. Conn Assignments
All Deel groups
(x2) (34.8%)
N
0
2
4
8 Kilometers


L. Conn Assignments
Addergoole / Massbrook group (42.4%)
N
0
2
4
8 Kilometers


L. Conn Assignments
Castlehill R. group (11.8%)
N
0
2
4
8 Kilometers


N
Tobergal R. group (23.6%)
0
2
4
8 Kilometers
L. Cullin Assignments


All Deel groups
(x2) (16%)
N
0
2
4
8 Kilometers
L. Cullin Assignments


Addergoole / Massbrook group (23.6%)
N
0
2
4
8 Kilometers
L. Cullin Assignments

Rivers Not Contributing to L. Conn, Cullin or the Sea Trout population
Castlebar R.
Gweestion (Glore)
Trimogue R.
Fiddaunglass Stream (?)
Manulla R.
Owenaher R.
Yellow R. (?)

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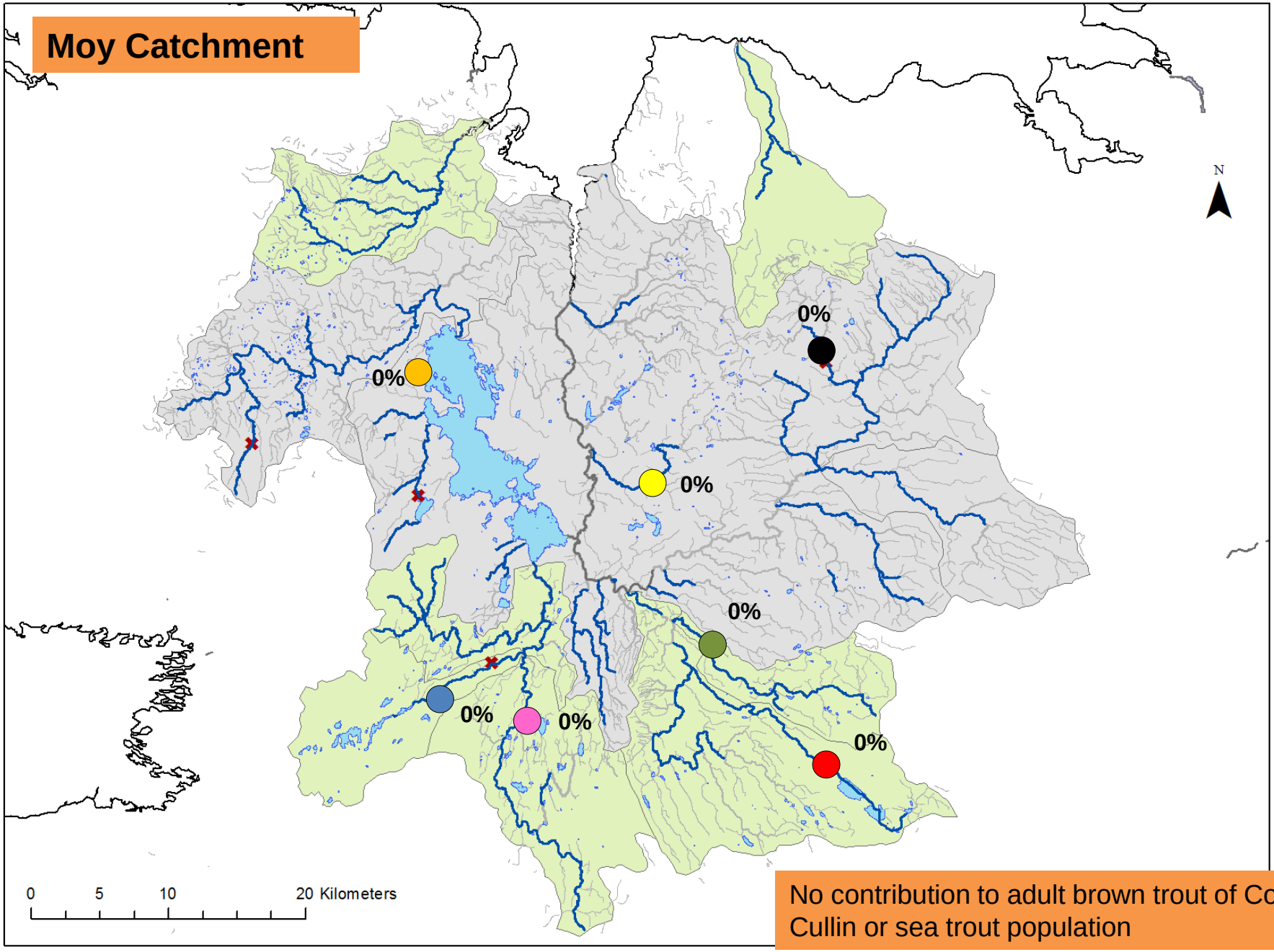

Moy Catchment
N
0%
0%
0%
0%
0%
0%
0%
0
5
10
20 Kilometers
No contribution to adult brown trout of Conn, Cullin or sea trout population

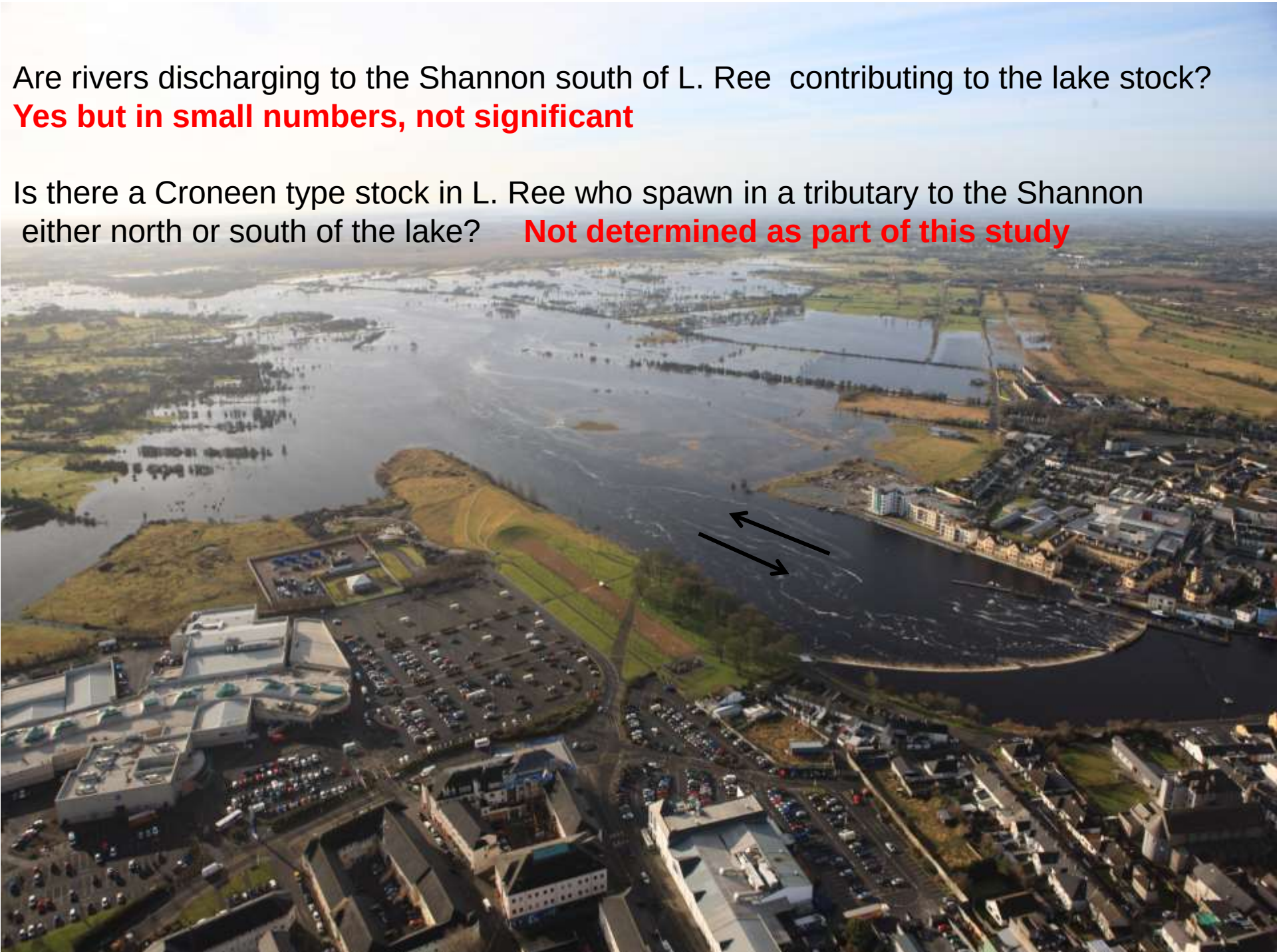
Questions in relation to the mid-Shannon area.

- The origin of trout in Lough Ree **Done**
- Are they mostly fish from rivers discharging directly to the Lough? **Approx. 50%**
- How important are these individual rivers in relative terms? **Only Inny R. important**

Do any fish recruit to L Ree from tributaries which discharge to the Shannon u/s of Lanesboro? **Yes – Camlin R. mainly**

Are rivers discharging to the Shannon south of L. Ree contributing to the lake stock?
Yes but in small numbers, not significant

Is there a Croneen type stock in L. Ree who spawn in a tributary to the Shannon either north or south of the lake? **Not determined as part of this study**



Where do the L. Derravaragh trout stock originate? **Mainly Inny main channel, Riffey R. and Yellow R. (Derravaragh)**

Do they mix with the Ree or Sheelin populations? **Extremely limited mixing with L. Ree, Sheelin element not known yet.**

In summertime there is a stock of adult trout in the River Inny. **Yes**

Are these an independent stock or a part of the Ree or Derravaragh genetic groups?

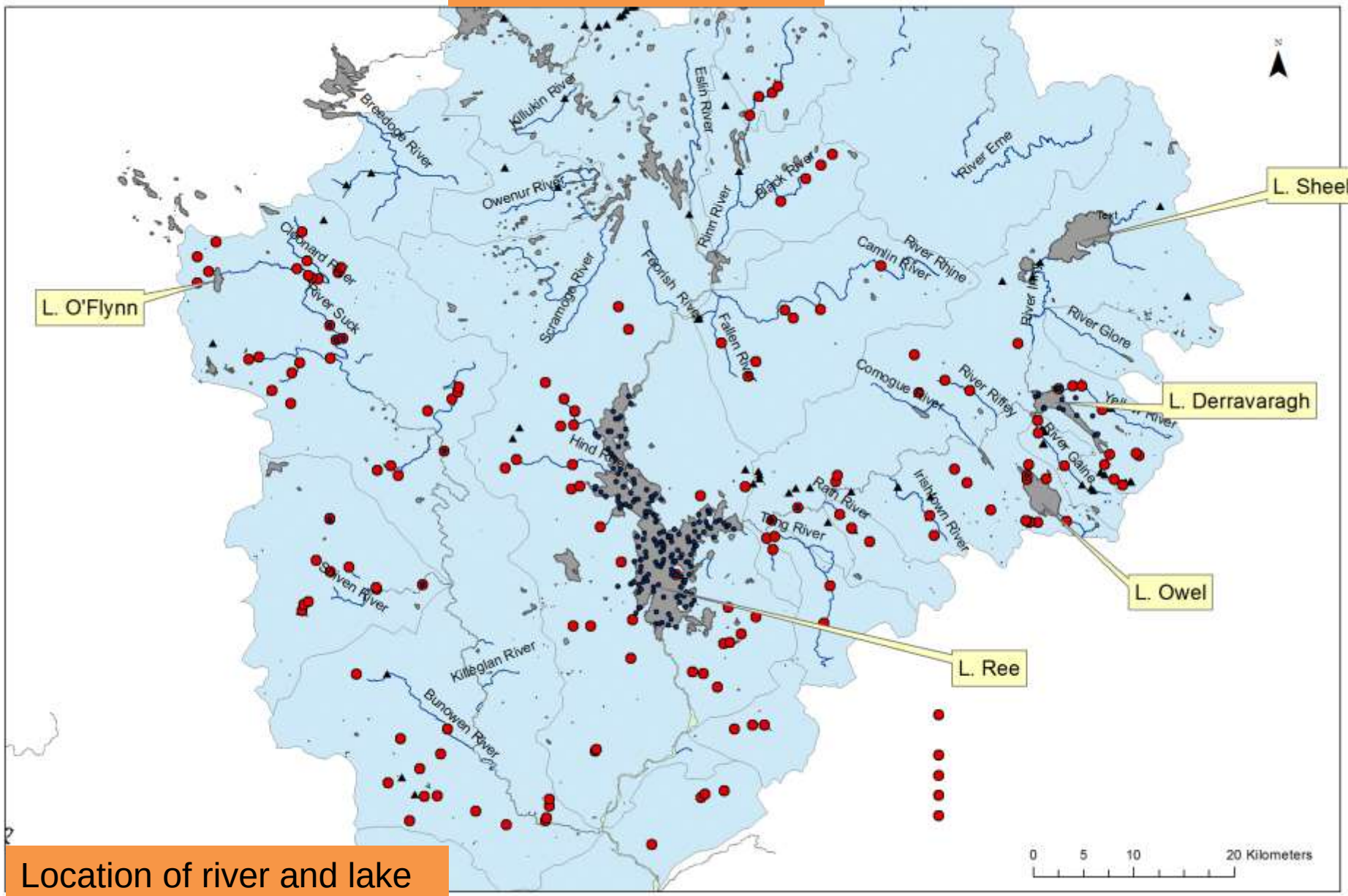
Inny adults come from the Inny main channel

Inny juveniles supply adults to Inny main channel, L. Derravaragh and L. Ree in significant numbers

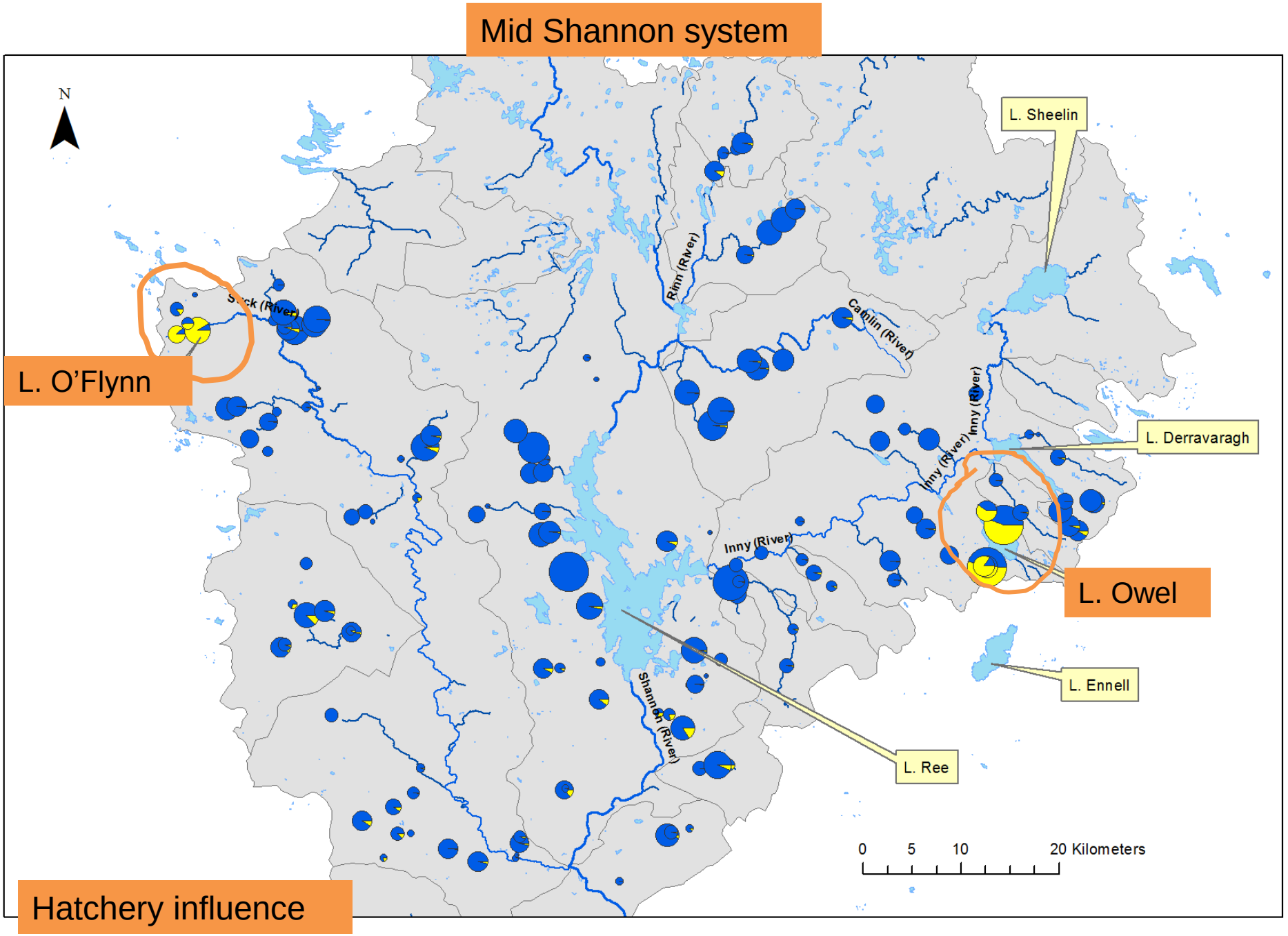
Do trout stocks from the Suck make any contribution to the L. Ree population?

Yes though in very small numbers (this survey 6 Suck system juveniles found in L. Ree as adults

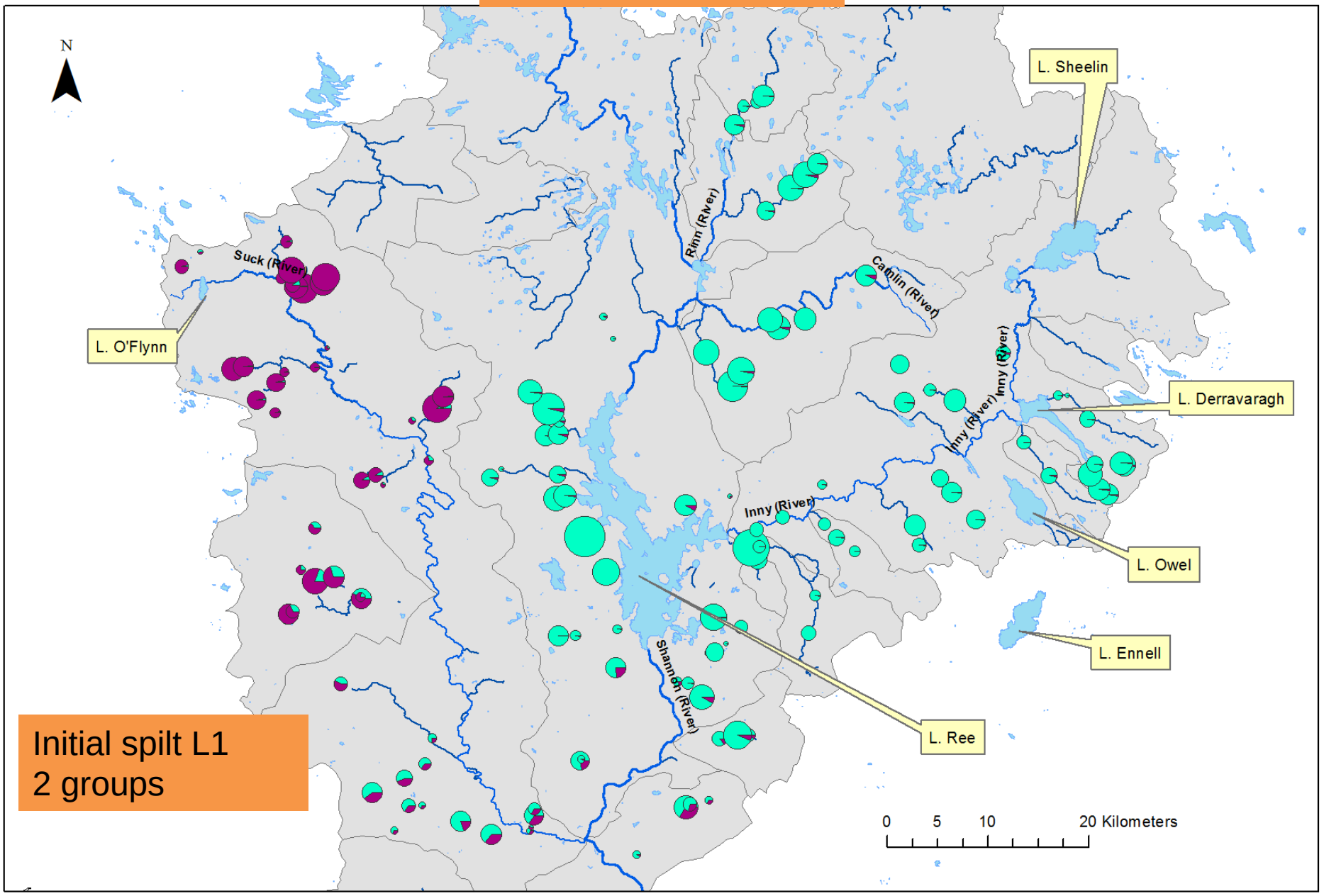
Mid Shannon system



Location of river and lake samples

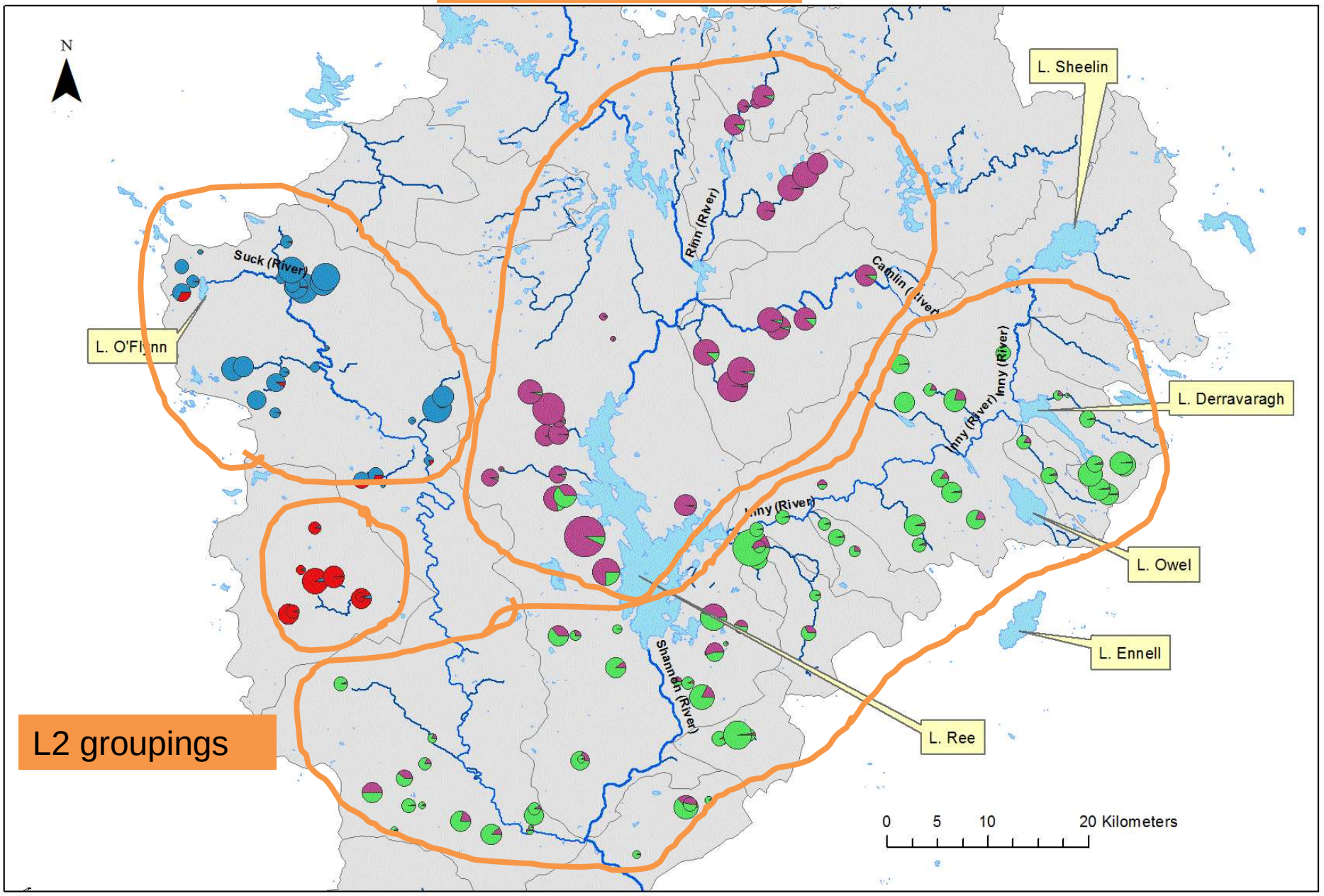

Mid Shannon system
N
L. Sheelin
Rinn (River)
Camlin (River)
Inny (River)
Inny (River)
Inny (River)
L. Derravaragh
L. O'Flynn
L. Owel
L. Ennell
Shannon (River)
L. Ree
0
5
10
20 Kilometers
Hatchery influence

Mid Shannon system

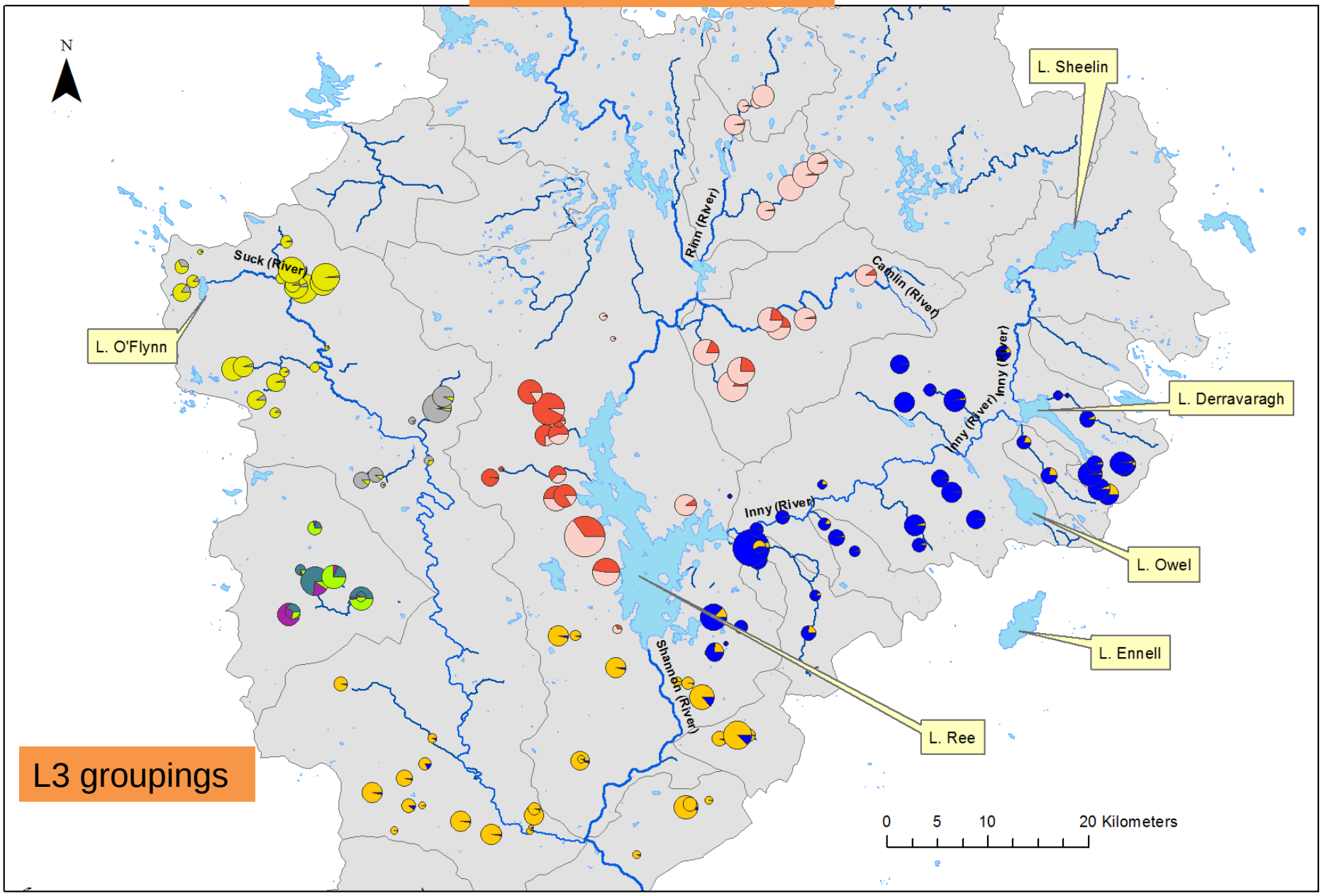


Initial spilt L1
2 groups

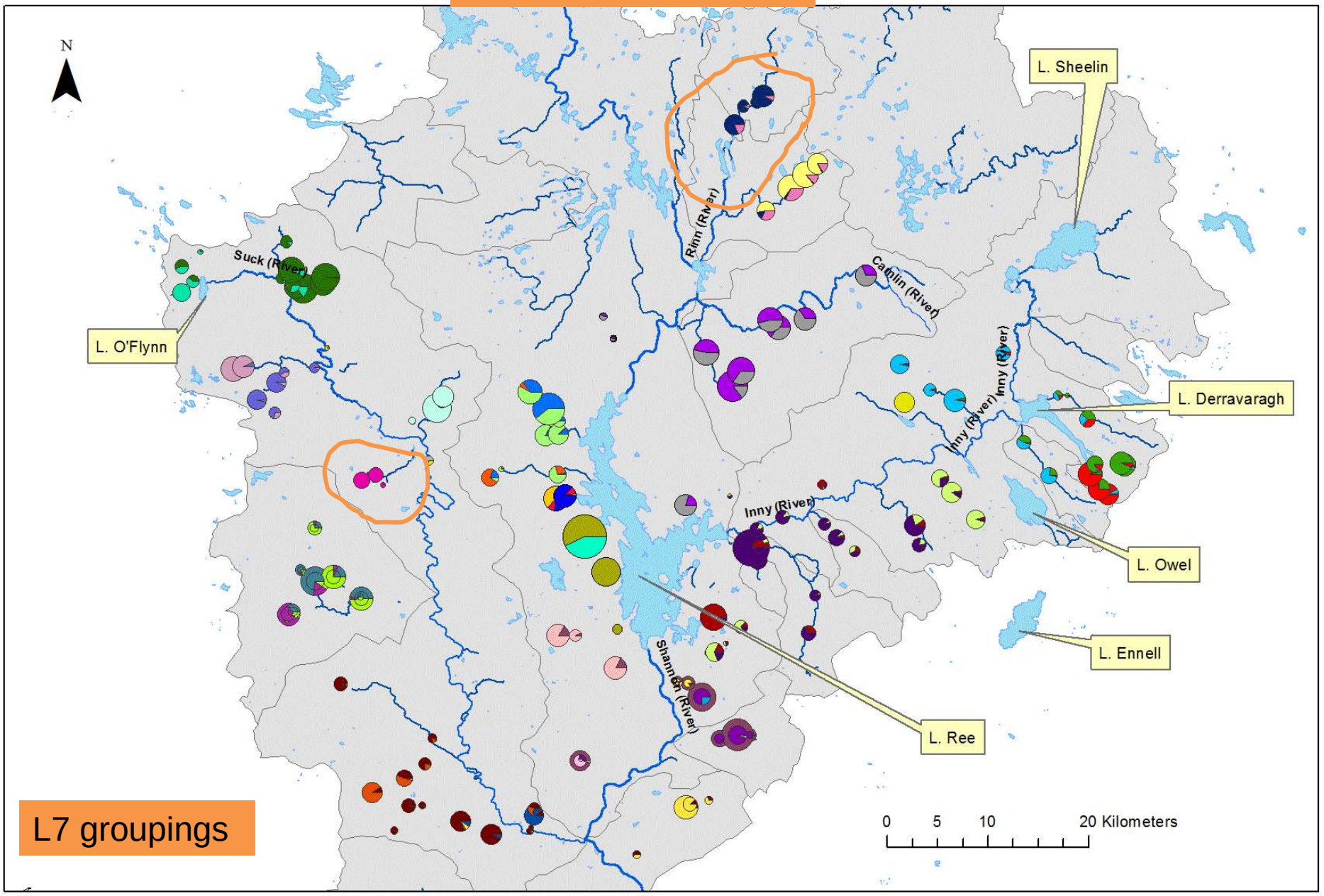
Mid Shannon system



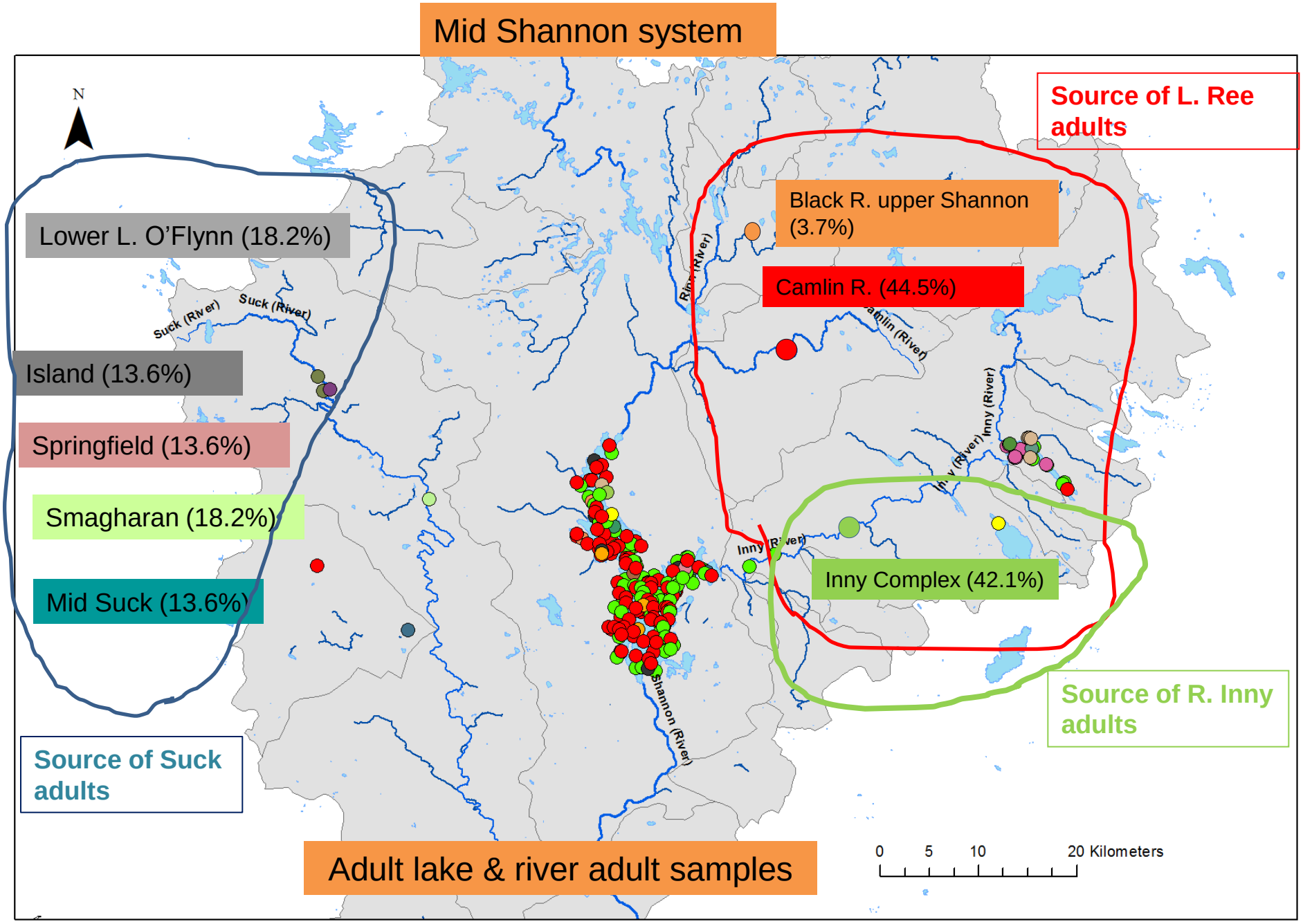
L2 groupings

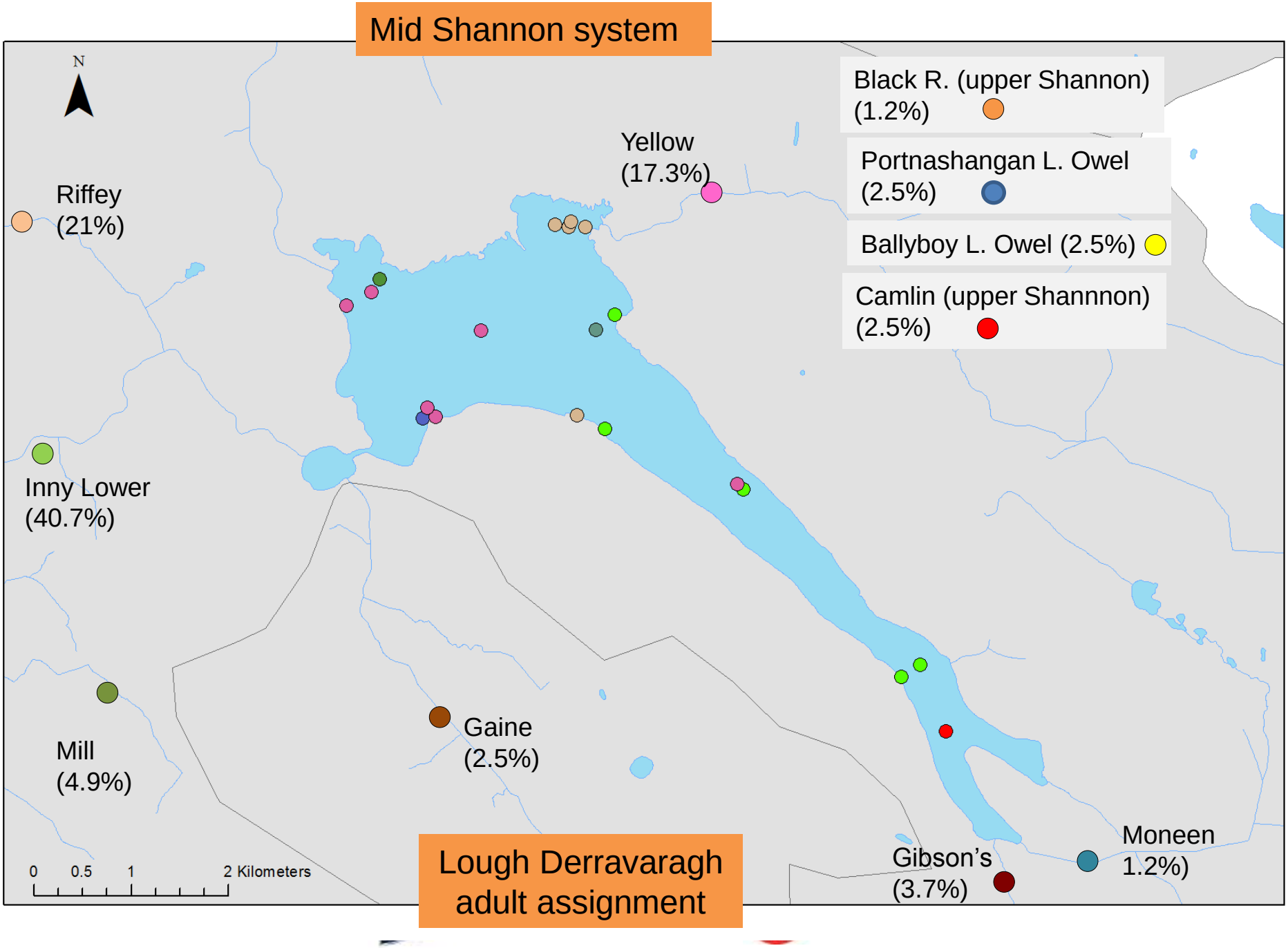

Mid Shannon system
N
L. Sheelin
Rinn (River)
Camlin (River)
Suck (River)
L. O'Flynn
Inny (River)
Inny (River)
Inny (River)
L. Derravaragh
L. Owel
L. Ennell
Shannon (River)
L. Ree
L3 groupings
0
5
10
20 Kilometers

Mid Shannon system

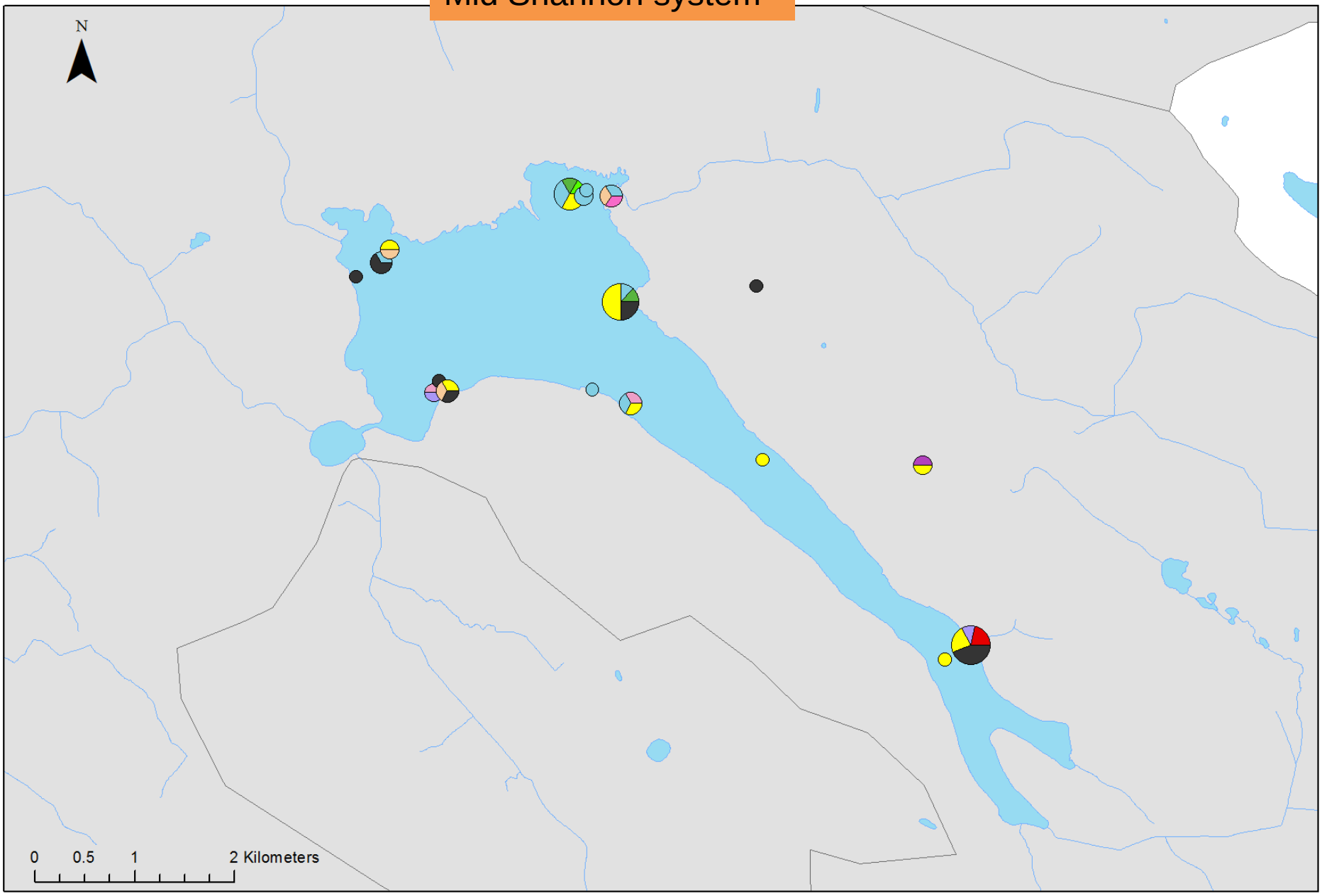


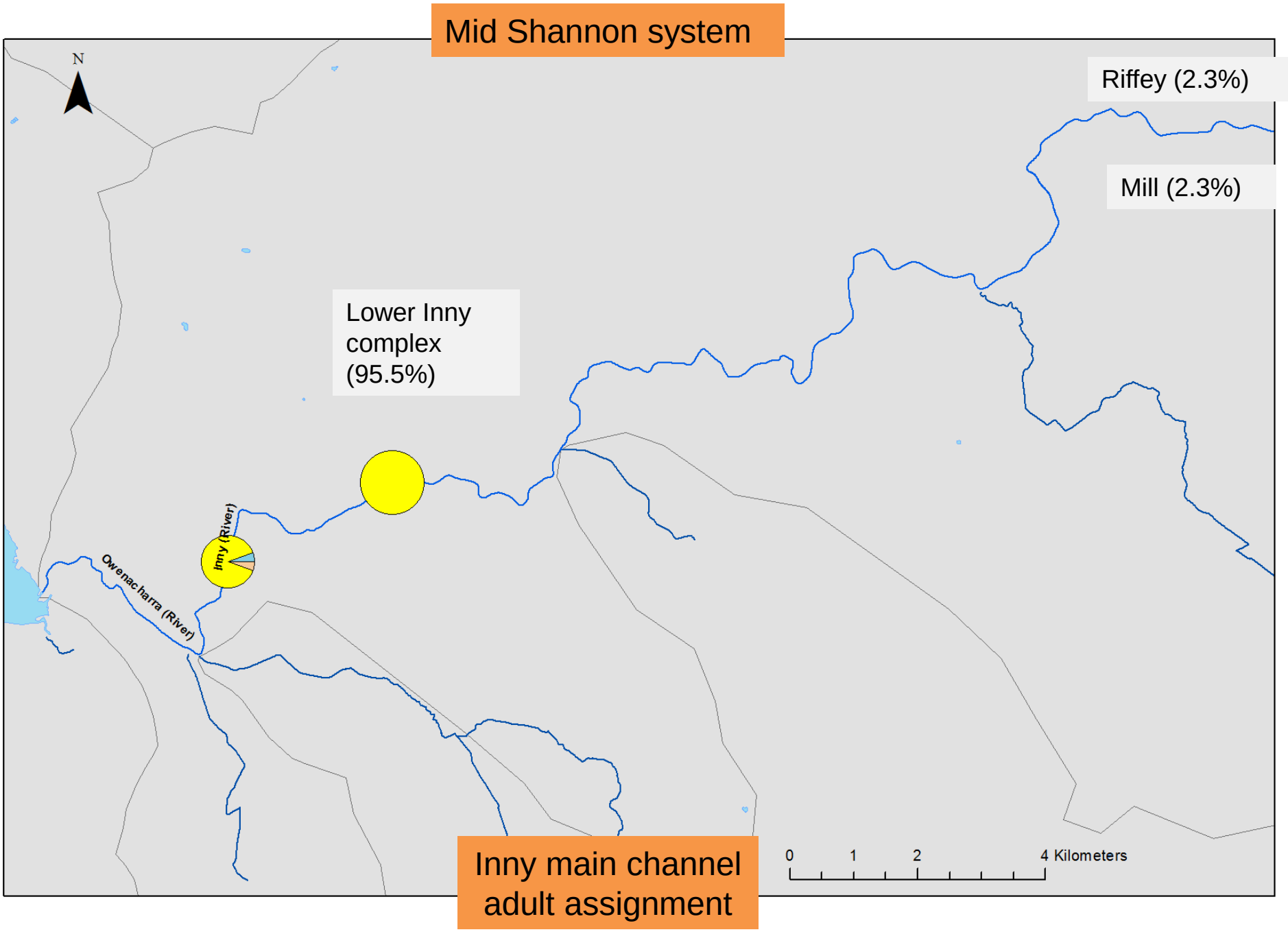
L7 groupings

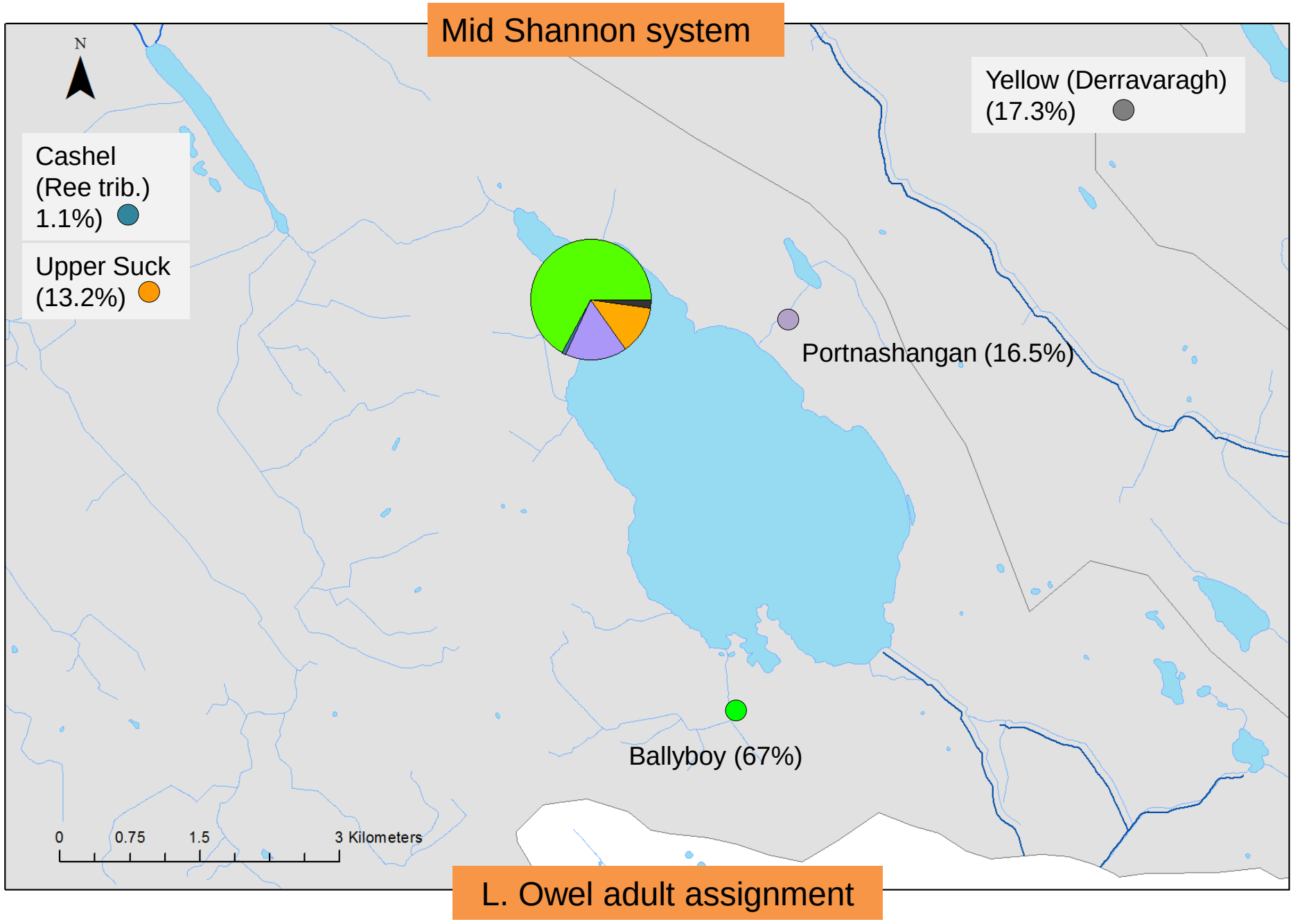

Mid Shannon system
N
Source of L. Ree adults
Black R. upper Shannon (3.7%)
Camlin R. (44.5%)
Lower L. O'Flynn (18.2%)
Island (13.6%)
Springfield (13.6%)
Smagharan (18.2%)
Mid Suck (13.6%)
Inny Complex (42.1%)
Source of R. Inny adults
Source of Suck adults
Suck (River)
Suck (River)
Shannon (River)
Inny (River)
Adult lake & river adult samples
0
5
10
20 Kilometers


Mid Shannon system
N
Black R. (upper Shannon)
(1.2%)
Portnashangan L. Owel
(2.5%)
Ballyboy L. Owel (2.5%)
Camlin (upper Shannnon)
(2.5%)
Yellow
(17.3%)
Riffey
(21%)
Inny Lower
(40.7%)
Gaine
(2.5%)
Mill
(4.9%)
Moneen
1.2%)
Gibson's
(3.7%)
0 0.5 1 2 Kilometers
Lough Derravaragh
adult assignment

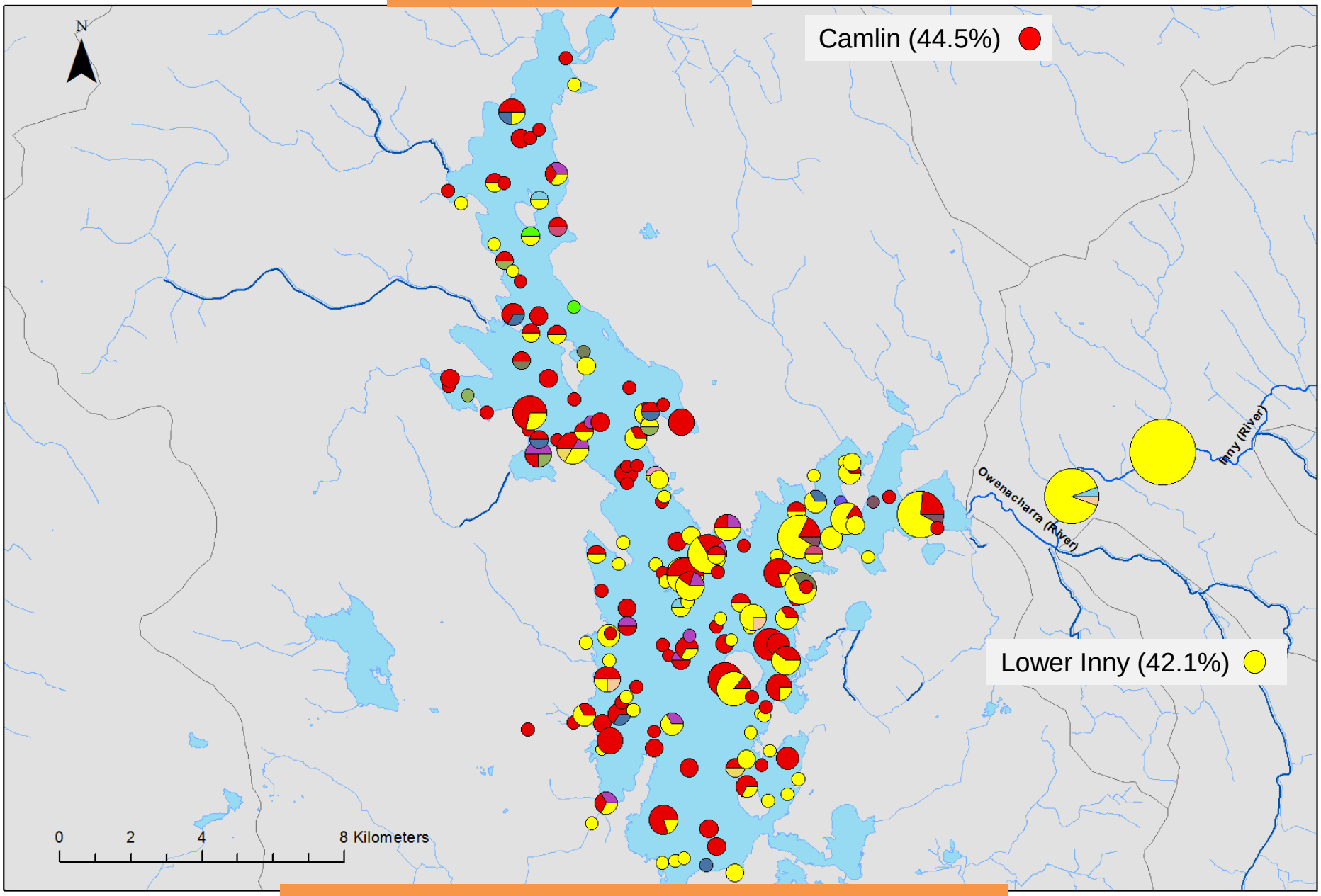
Mid Shannon system



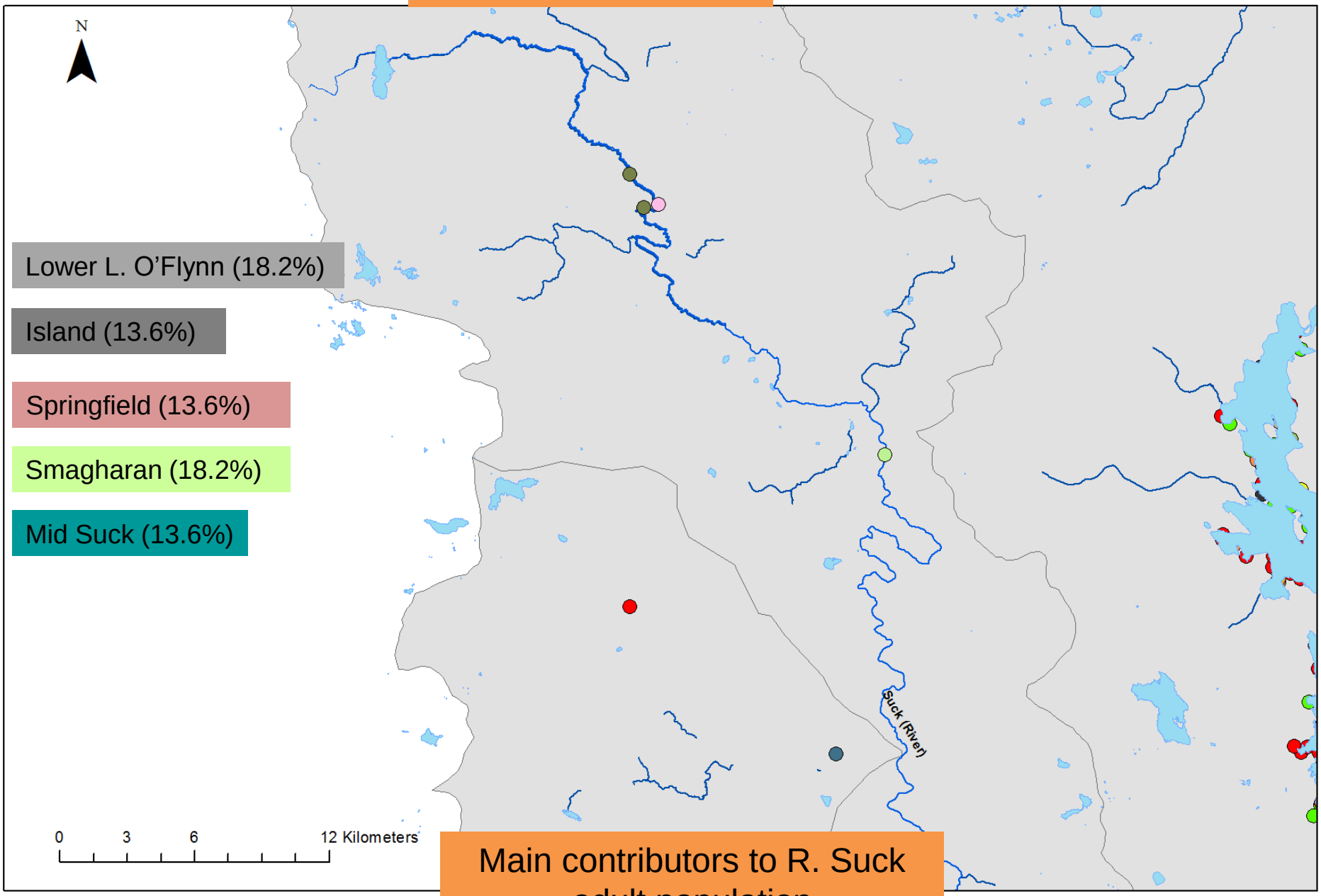

Mid Shannon system
N
Riffey (2.3%)
Mill (2.3%)
Lower Inny complex (95.5%)
Inny (River)
Owenacharra (River)
0
1
2
4 Kilometers
Inny main channel adult assignment


Mid Shannon system
N
Cashel
(Ree trib.)
1.1%)
Upper Suck
(13.2%)
Yellow (Derravaragh)
(17.3%)
Portnashangan (16.5%)
Ballyboy (67%)
0
0.75
1.5
3 Kilometers
L. Owel adult assignment

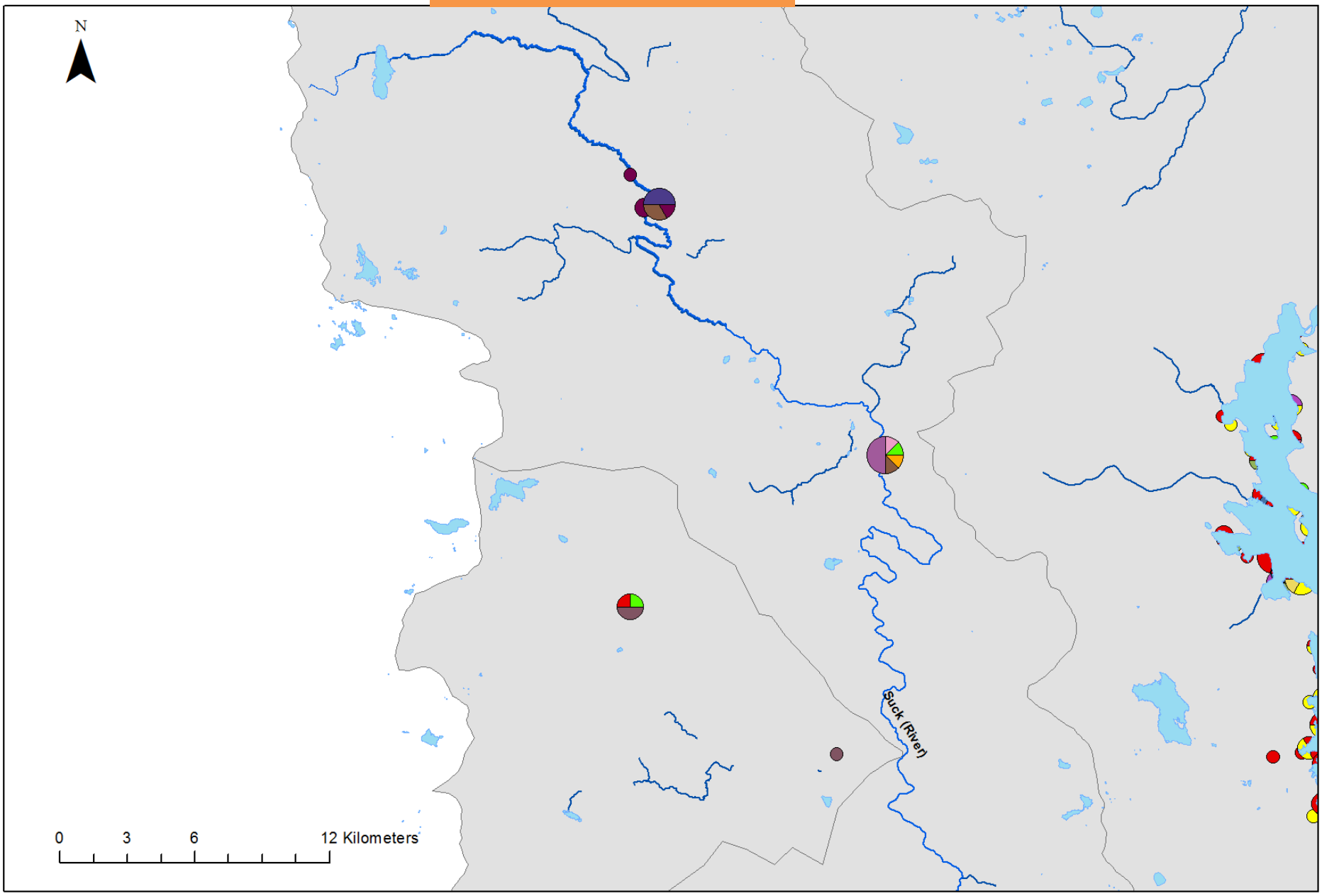
Mid Shannon system



Main contributors to L. Ree adult population


Mid Shannon system
N
Lower L. O'Flynn (18.2%)
Island (13.6%)
Springfield (13.6%)
Smagharan (18.2%)
Mid Suck (13.6%)
Suck (River)
0
3
6
12 Kilometers
Main contributors to R. Suck adult population

Mid Shannon system



	Adult location				
Inferred Structure baseline	**Derravaragh**	**Inny**	**Lough Ree**	**Owel**	**Suck**
Black_River_Upper_Shannon	1 (1.2%)	-	14 (3.7%)	-	-
Camlin_Upper_Shannon	2 (2.5%)	-	167 (44.5%)	-	1 (4.5%)
Ree_Inflow_NW	-	-	7 (1.9%)	-	-
Lecarrow_Ree_Inflow_W	-	-	2 (0.5%)	-	-
Hind_Ree_Inflow_W	-	-	5 (1.3%)	-	-
Cashel_Ree_Inflow_E	-	-	8 (2.1%)	1 (1.1%)	-
Lower_Inny_Complex	33 (40.7%)	42 (95.5%)	158 (42.1%)	-	-
Keshahurry_Riffey_Upper_Inny	17 (21%)	1 (2.3%)	2 (0.5%)	-	-
Mill_Upper_Inny	4 (4.9%)	1 (2.3%)	2 (0.5%)	-	-
Gaine_Upper_Inny_Derravaragh	2 (2.5%)	-	1 (0.3%)	-	1 (4.5%)
Gibson_Upper_Inny_Derravaragh	3 (3.7%)	-	-	-	-
Moneen_Upper_Inny_Derravaragh	1 (1.2%)	-	-	-	-
Yellow_Upper_Inny_Derravaragh	14 (17.3%)	-	-	2 (2.2%)	-
Ballyboy_Lough Owel	2 (2.5%)	-	3 (0.8%)	61 (67%)	2 (9.1%)
Kilpatrick_Portnashangan_Lough_Owel	2 (2.5%)	-	-	15 (16.5%)	-
Lower_Suck_Complex	-	-	1 (0.3%)	-	-
Deerpark_Lower_Suck	-	-	2 (0.5%)	-	-
Mid_Suck_Complex	-	-	3 (0.8%)	-	3 (13.6%)
Smagharan_Mid_Suck	-	-	-	-	4 (18.2%)
Springfield_Upper_Suck	-	-	-	-	3 (13.6%)
Island_Upper_Suck	-	-	-	-	3 (13.6%)
Upper_Suck_Lower_OFlynn	-	-	-	-	4 (18.2%)
Upper_Suck_Upper_OFlynn	-	-	-	12 (13.2%)	1 (4.5%)
Grand Total	81 (100%)	44 (100%)	375 (100%)	91 (100%)	22 (100%)

Need to update

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No Contribution to adult population from:
Breensford R.
Tubrit R.
Boor R.
Glasson
Cross R.
Knockcroughery
Clooneigh
Black (Inny) Stream
Blackwater (Shannon) R.
Camcloon R.
Cloone R.
Feorish

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Dublin Rivers

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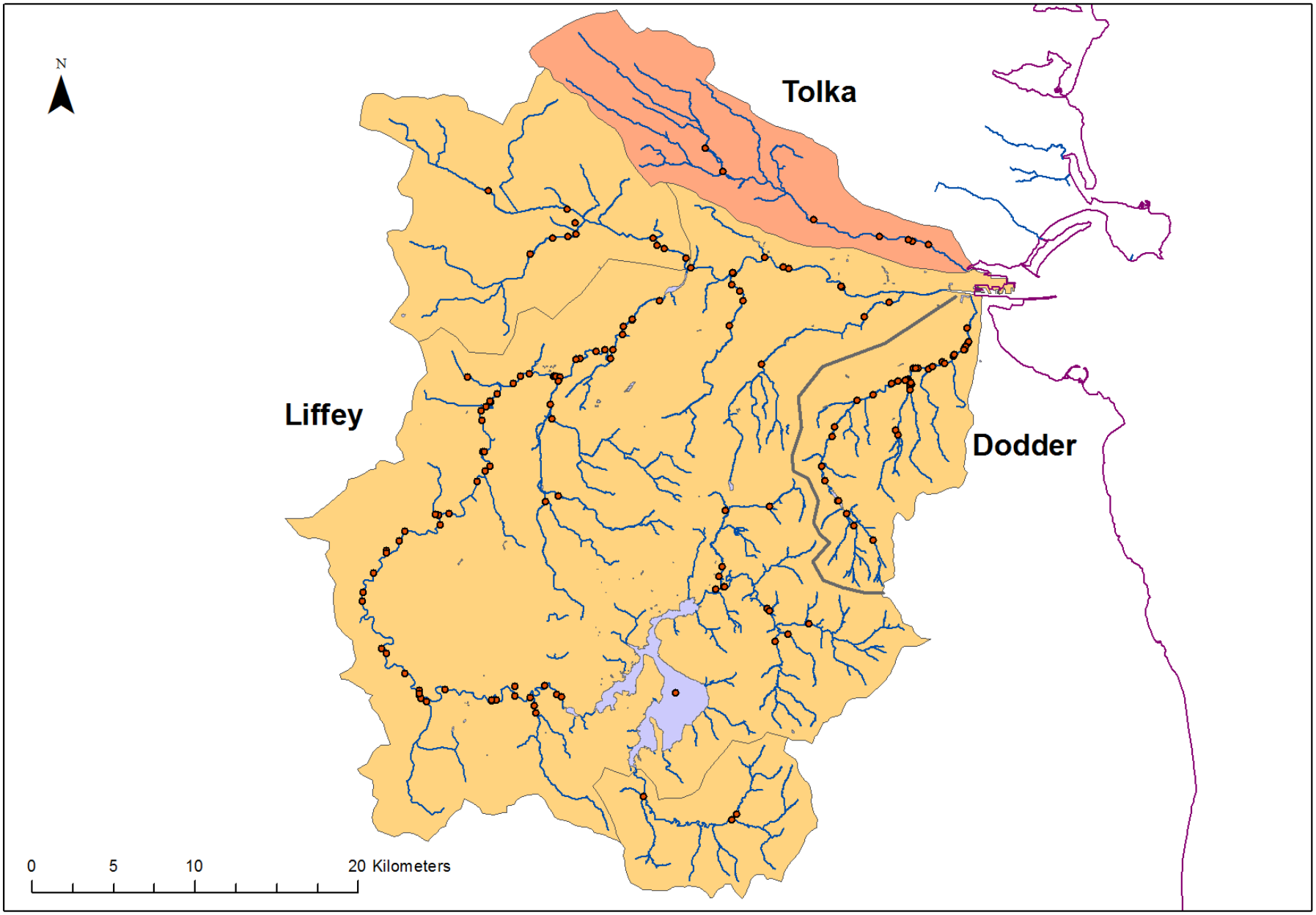
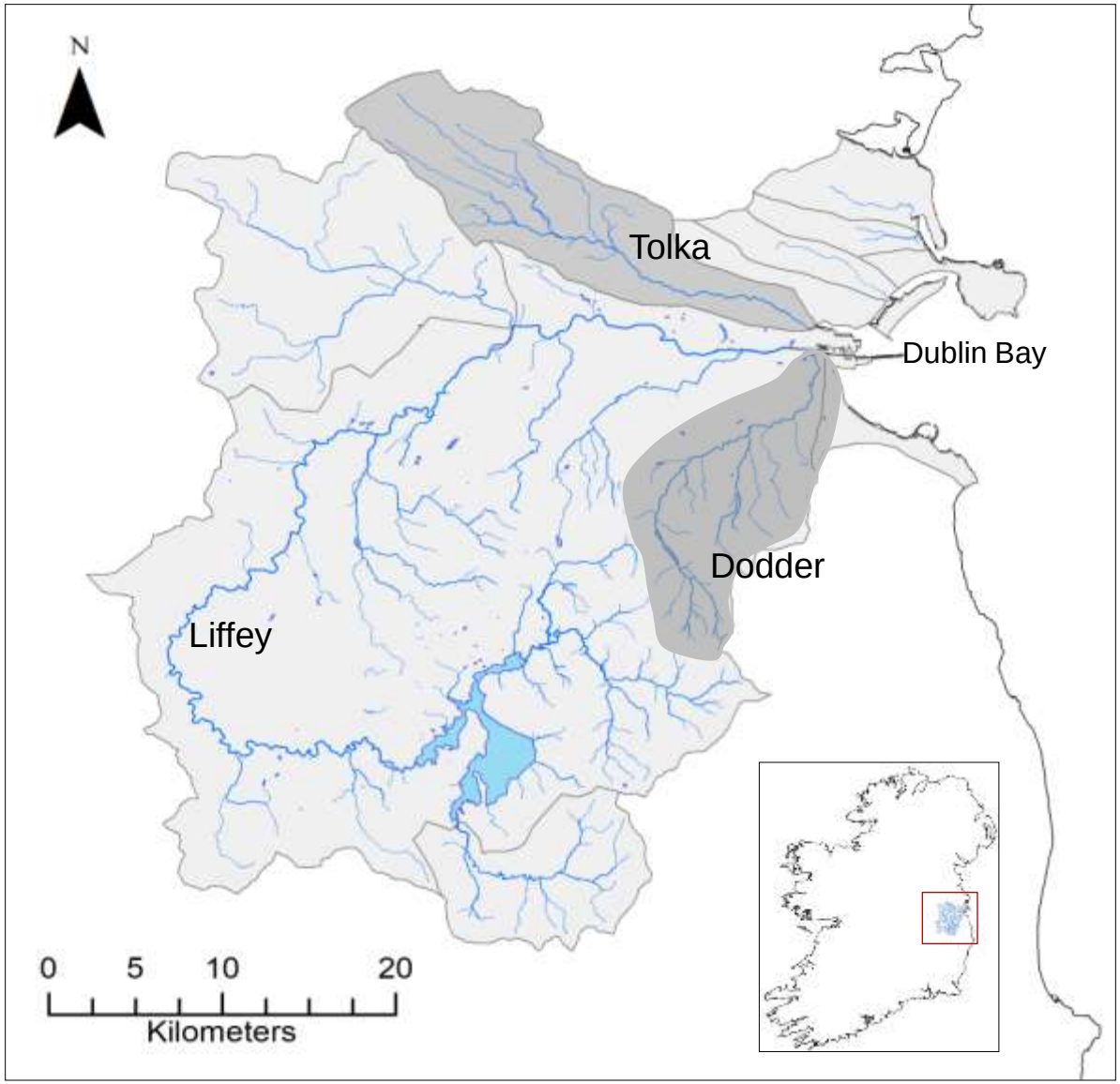

N
Tolka
Liffey
Dodder
0
5
10
20 Kilometers



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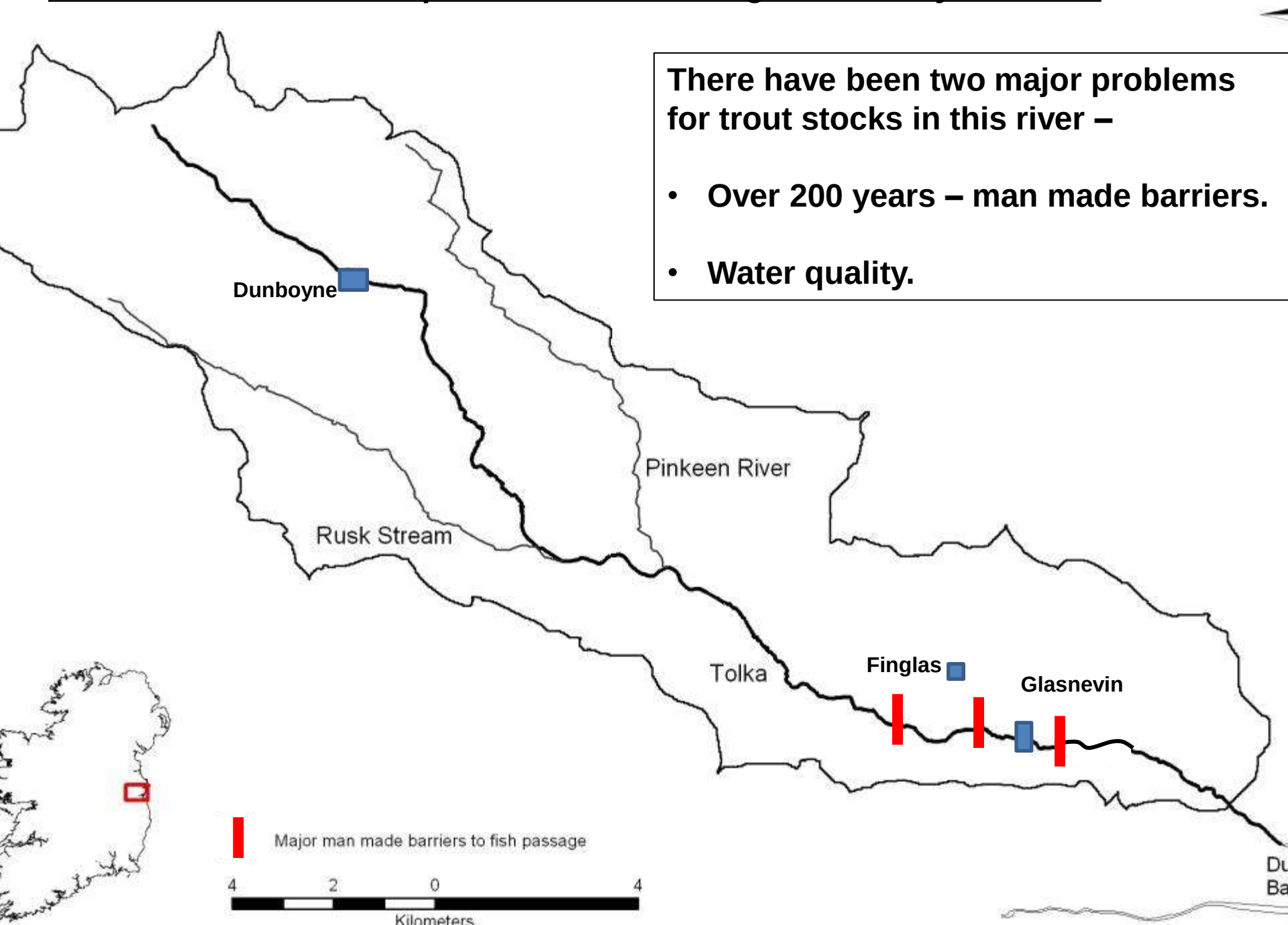
The Tolka River - What questions can a trout genetic study answer ?



Tolka: **2 genetic groupings**

Dodder: **5 genetic groupings**

Liffey: **10 genetic groupings**

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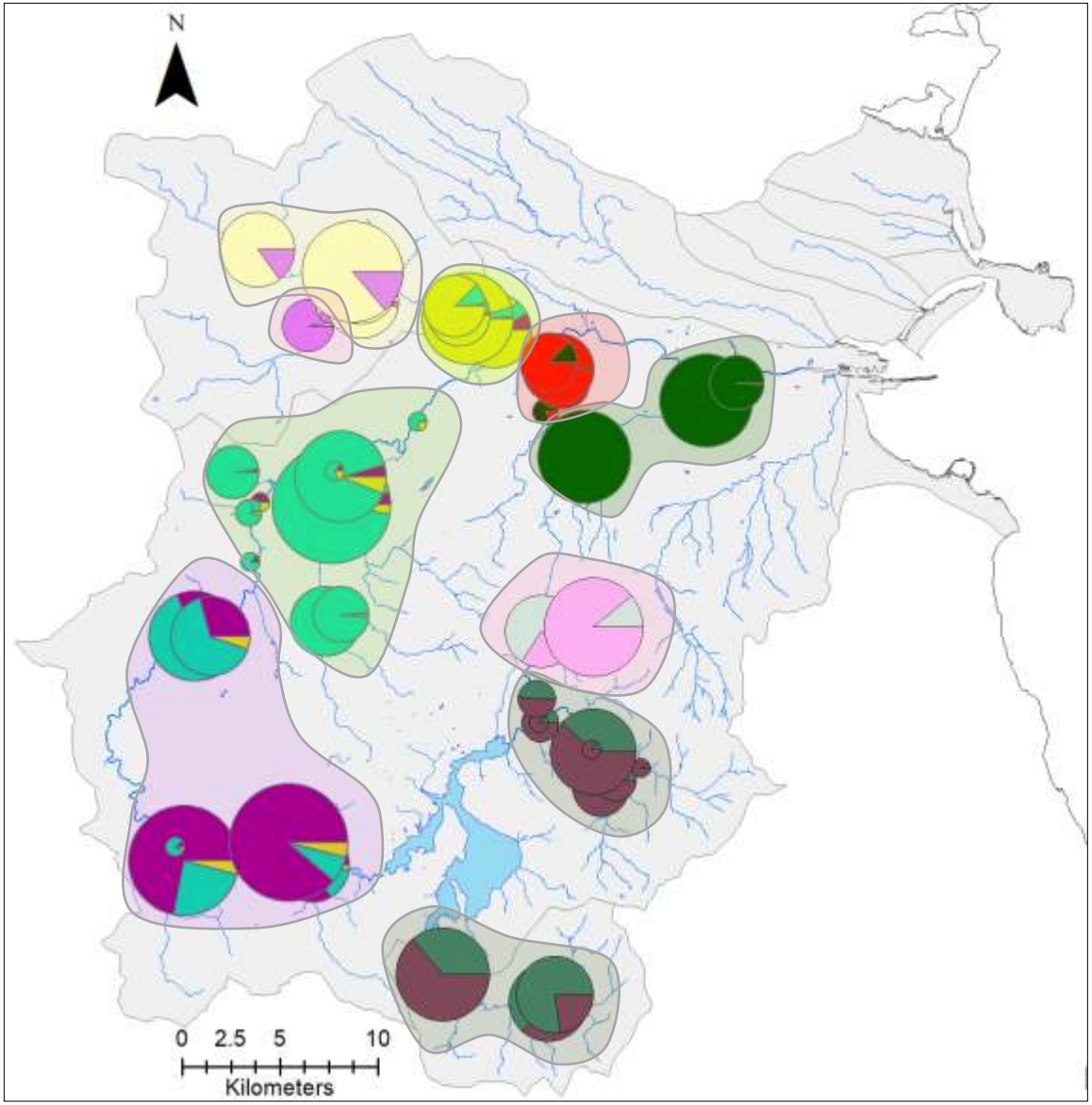

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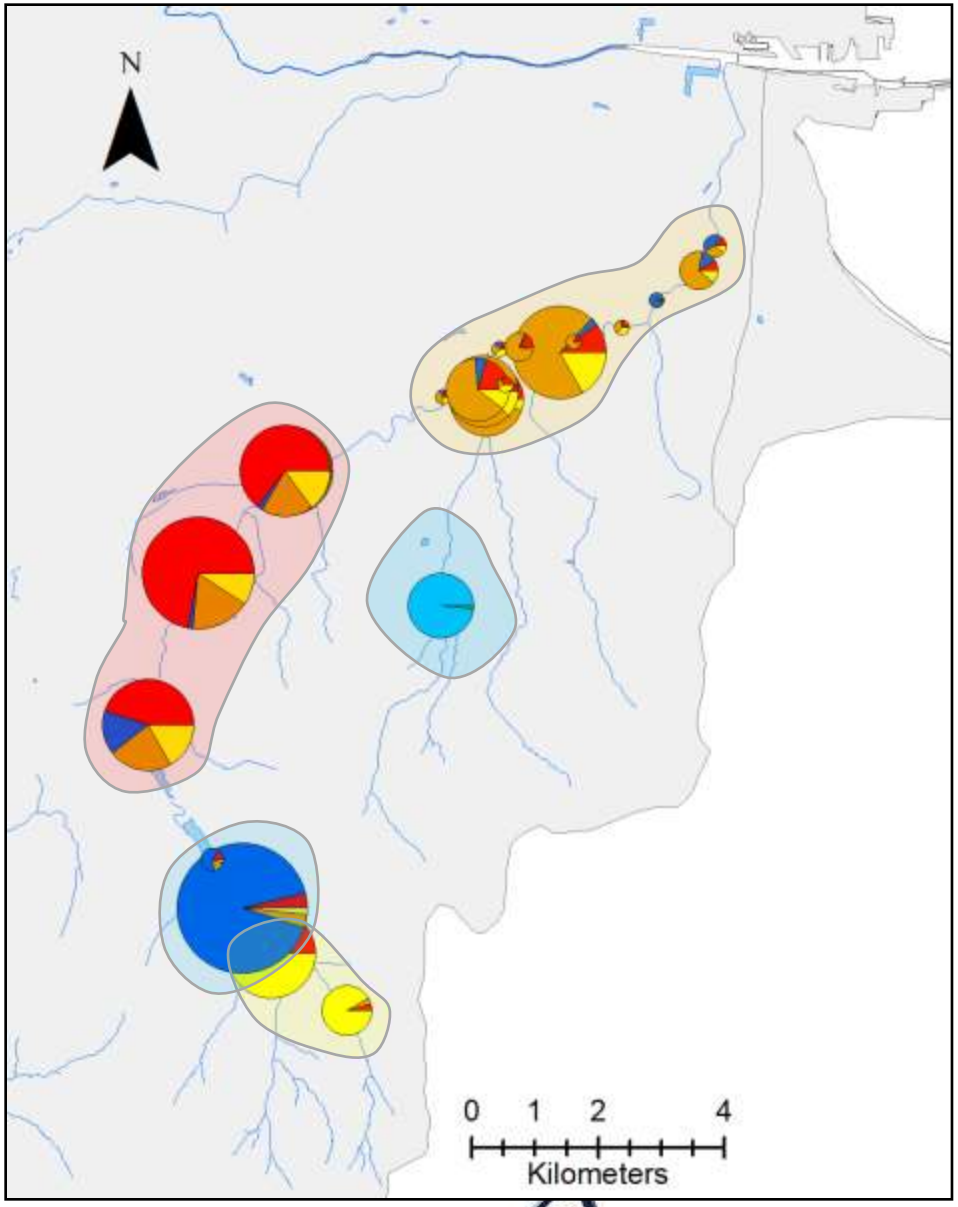

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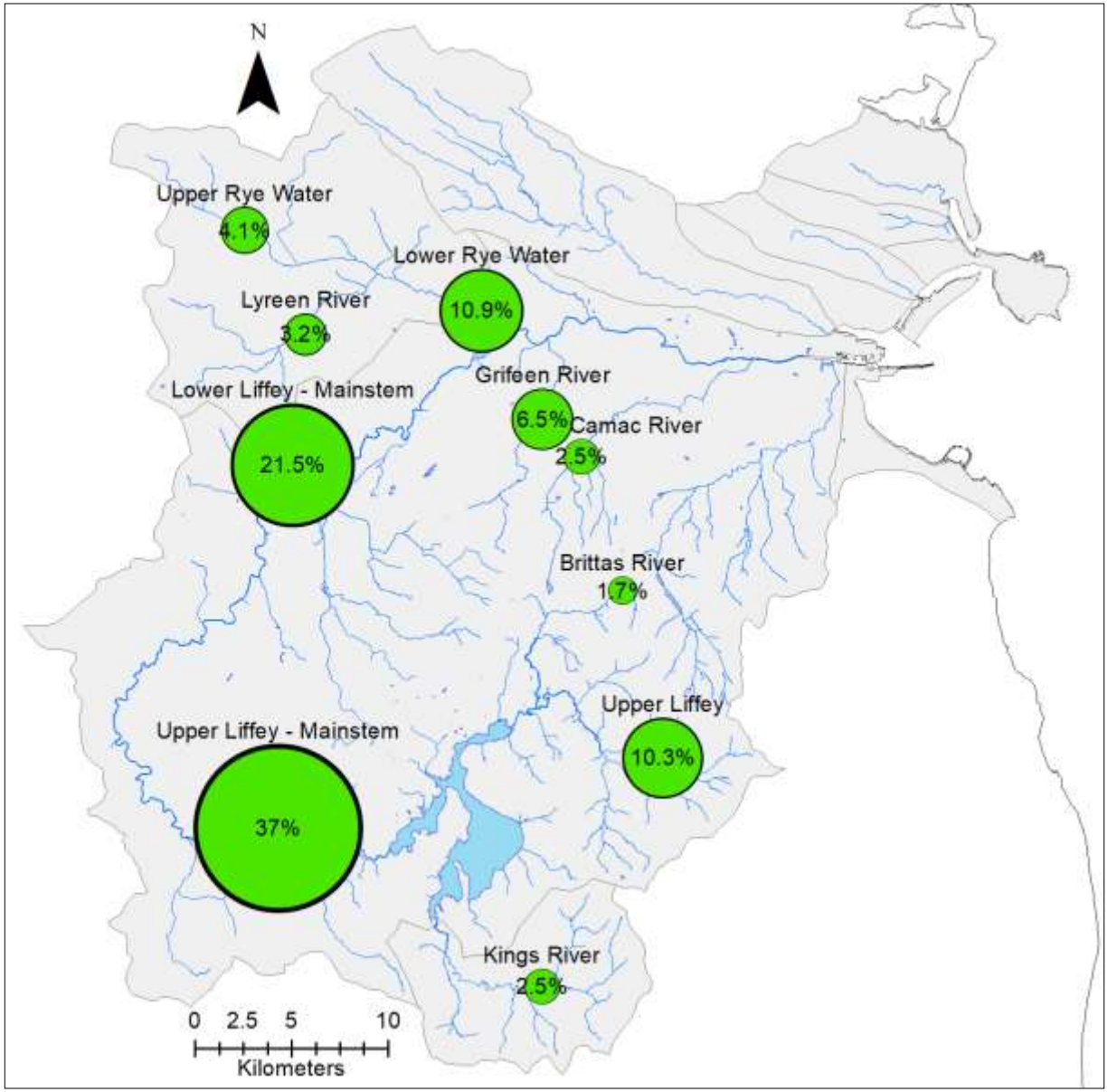
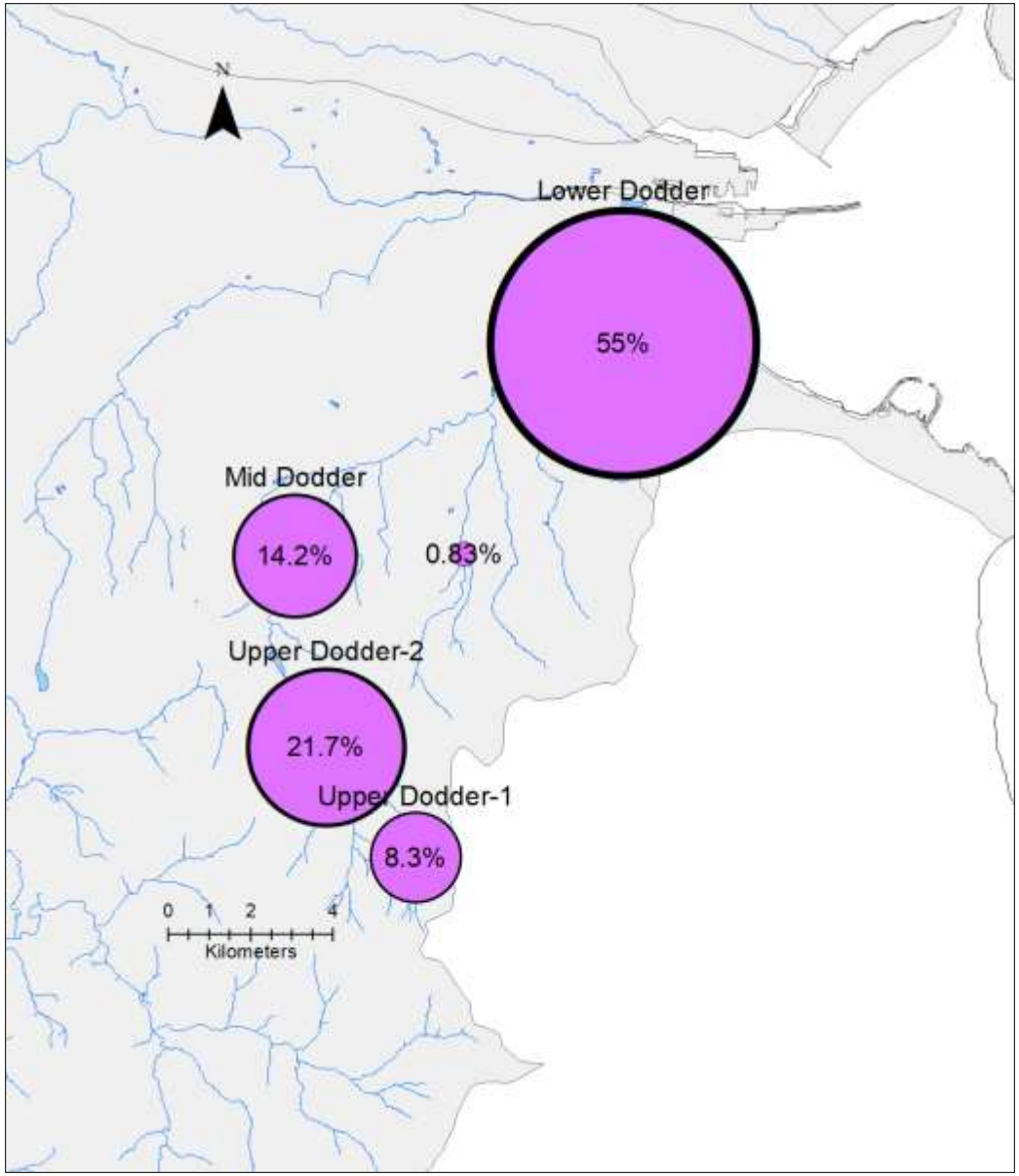
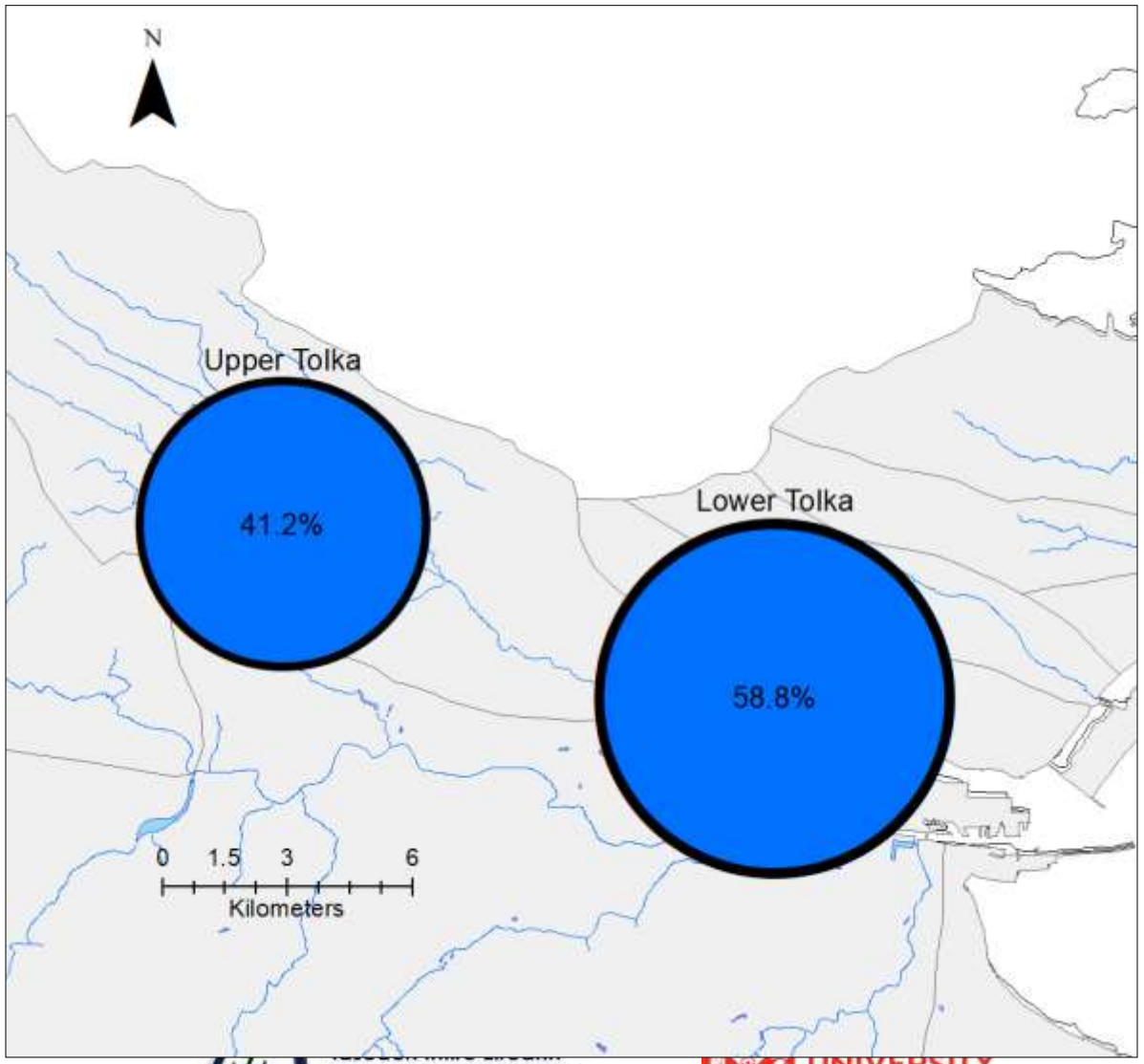
Liffey baseline contribution to adult stock



Dodder baseline contribution to adult stock



Tolka baseline contribution to adult stock



Common Issues not only for

Dublin Rivers but nearly all

larger catchments

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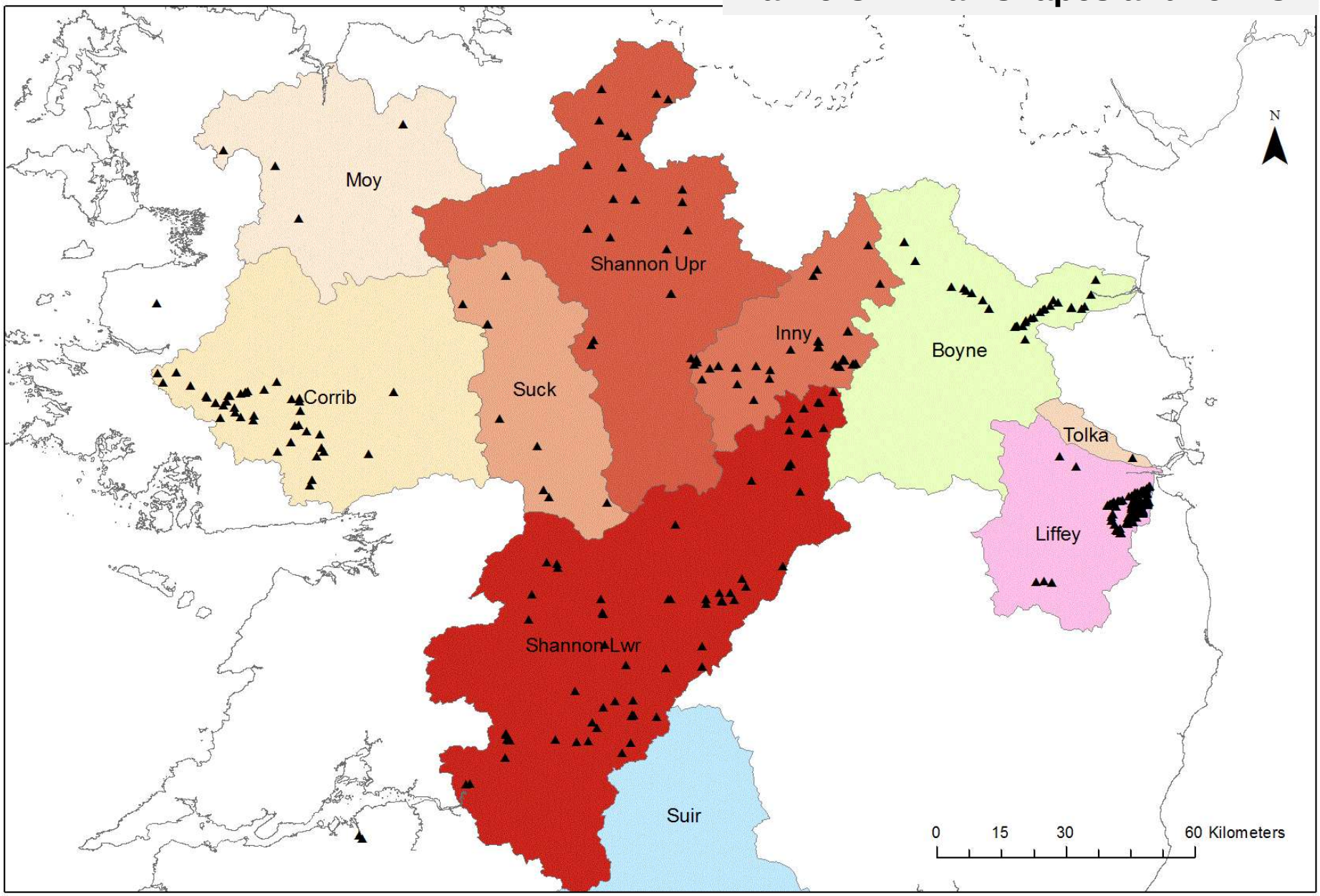
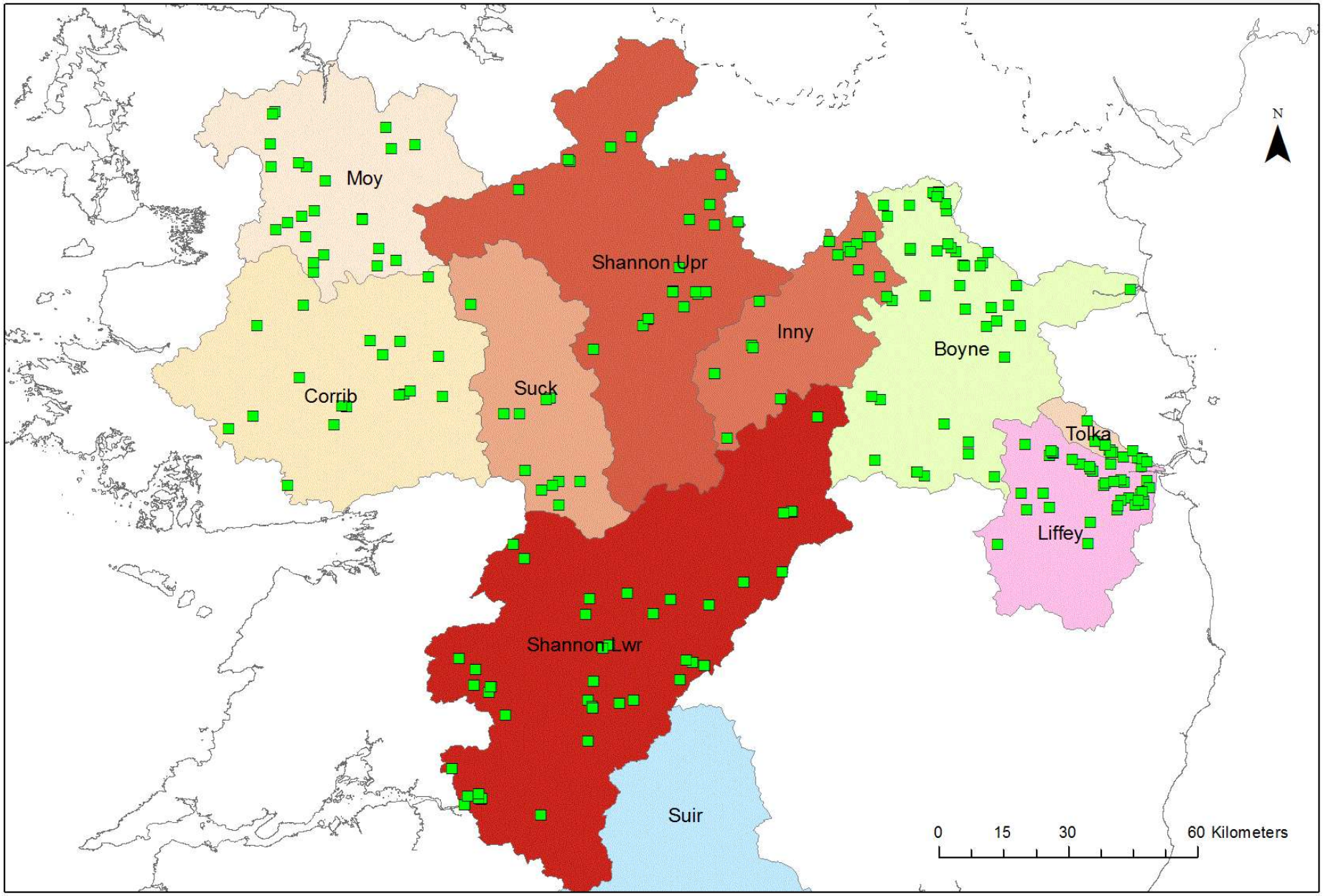
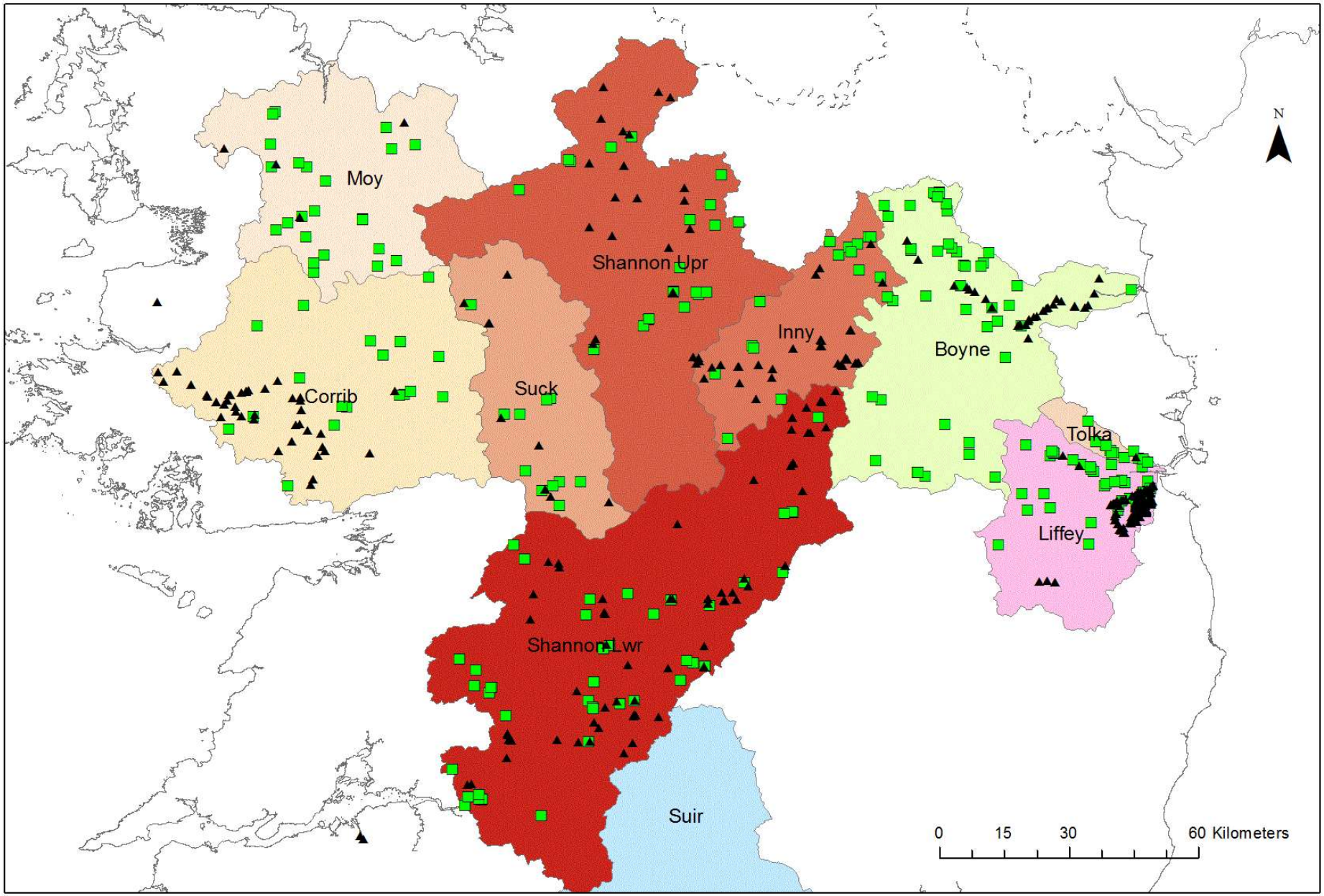
Barriers – in all shapes and forms



Water quality issues




Moy
Shannon Upr
Inny
Boyne
Corrib
Suck
Tolka
Liffey
Shannon Lwr
Suir
N
0
15
30
60 Kilometers

Summary

- A combination of our existing morphological and ecological databases in combination with this new genetic information provides a more extensive insight into the dynamics and interaction of brown trout stocks in larger catchments.

- Has highlighted the fact that some trout populations are virtually sedentary while others are extremely mobile, travelling long distances.

- There are a number of discrete “families” of trout in all of our larger catchments.

- Adult trout stocks in the main stems of at least two of our larger rivers (Suir and Boyne) are fishes of tributary origin and are thoroughly mixed as a stock in the main stem.

- Data is provided which suggests that anthropogenic activities can, sometimes, impact on the natural distribution of trout stocks.

- An initial investigation on the impact of the stocking of inbred hatchery trout suggests that it does not appear to have had any long-term effect on the genetic integrity of wild trout populations.

- These studies highlight the fact that “nature” has its own restocking system whose existence clearly negates the necessity for man-made hatcheries.

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Fishery Management Applications

- The availability of this “new genetics tool “allows one to;-
- Define the contribution of trout from individual sub catchments to lake or river main stem stocks in relative terms.
- In combination with ecological/morphological surveys the findings of a genetic study can help one to identify key sub catchments where enhancement programmes are likely to generate the best return on investment.
- A knowledge of the extent to which a trout stock has migratory or sedentary tendencies will help define the outcome of enhancement exercises – ie. will increased trout production improve the local population of a sedentary stock or contribute to a lake or main stem river population downstream by increasing the output of a migratory population?
- Genetic data in relation to main stem riverine adult brown trout stocks suggest that the population in such channels is a “mixed stock fishery”.

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Fishery Management Applications

- In conservation terms these programmes clearly have a role to play in identifying the sub populations of these fish which are genetically unique to ensure that their status, as such, is recognised and that they are afforded special protection in the long term.

- Over long periods of time will be useful in illustrating how the balance of stocks in the larger catchments are changing.

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Thank You

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