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**Stocking Briefing: Past hatchery Output in relation to the Natural hatchery of the River Beauly v2**

As Marine Scotland are reviewing their stocking policy, it is timely to put the Beauly’s past stocking operation into context.

Currently, stocking can be licensed where the benefit to a salmon population outweighs the risk to it. For example, ‘Mitigation’ stocking is currently allowed as a last resort to help mitigate significant human impact (e.g. on the R. Conon). ‘Restoration’ stocking is sometimes allowed to restore salmon populations to how they were prior to a human impact (e.g. R. Garry, Ness). There is a presumption against all other forms of stocking, and this includes ‘enhancement’ stocking that used to occur on the Beauly.

It is important to highlight the **natural hatcheries** we have on the river and to be able to visualise what the contributions these, and past stocking activities look like relative to each other.

From communications with J. Mathieson, stocking occurred between 1991-2009. On an annual basis:

-150-250,000 fed salmon fry were stocked out in areas predominantly inaccessible to adult salmon (over a total wetted area of 204,708m2).

-20-40,000 autumn salmon parr were stocked out on the lower Beauly to smolt the following spring.

-Brood-stock were netted from Fasnakyle, and the lower Beauly and were a mixture of grilse and larger fish.

Average rod catch on the Beauly between 1991-2009 was 1327 fish**.**

Below I have attempted to:

1) Give a visual spatial estimate of what the annual hatchery out-put would have looked like.

2) Give a comparative estimate of annual rod return.

NBFT previously produced a report and advice note on the topic of stocking and these suggest that stocking is not appropriate for the river on an ecological and cost -efficiency basis [9], [10].

**Fry calculation**:

1) Using an average figure of 200,000 stocked fed fry, and using all data (274 surveys) from SFCC database from sites that are accessible to salmon (inc 2018 NEPS):

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| --- |
| The average minimum wild fry density at all sites across the Beauly catchment is **29 salmon fry per 100m2.** This will predominantly be settled fry numbers (end of summer) in juvenile habitat.  Aprahamian et al 2004 found that stocked fry survival rate to the end of summer is **20%**. This will vary river to river. Using this figure, the minimum number of stocked fry alive at the end of the summer (and equivalent to surveyed wild fry) would be 20% of 200,000 = **40,000 fry**  Using the Beauly’s wild juvenile densities **40,000 fry would use a maximum of 137,900m2** of juvenile habitat.  The R. Beauly is 63m wide adjacent to the Corff building.  To get a length of river we can imagine: 137,900m2/63m= a 2189m reach  Additionally, relative reproductive success for hatchery reared fry has been shown to be 0.71 of wild-born fish [7] so 71% of 2189m is **1554m**. |

**A 1.5km stretch of juvenile habitat on the R. Beauly would provide the equivalent annual fry output of the hatchery. This is similar to the distance between Home and Falls hut. For context, there is approximately 120km of accessible reach.**

2) Illustrative rod return calculation:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rod Catch Estimate based on a Comparison of the Fates of Wild Vs Stocked fry – illustrative only as not all survival rates are available for the Beauly.** | | | | |
| **Lifestage** | **Stocked** | **Wild equivalent** | **Comments** | **Ref** |
| **Fry** | 200,000 fed fry (100 fry per 100m2). Reduced to 40,000 by end of summer (19.5 fry per 100m2). | 59,160 (29 per 100m2) | Stocked numbers were well above background numbers for the Beauly. The longer brood stock progeny are in hatcheries the less well adapted they are to river life. Competition with existing native trout populations will also have impacted stocked fry survival but is not considered here. | [5] |
| **Parr** | 27,430 (13.4 parr per 100m2) | 27,430 (13.4 parr per 100m2) | Average minimum parr density in the Beauly catchment in juvenile habitat. Historic site data shows parr numbers are fairly stable. Parr numbers can be impacted through artificially high fry numbers. |  |
| **Smolts** | 6,000 -9,458 smolts | 13,715 smolts | **Survival to smolt is less for stocked fish.** Previous estimates of potential smolt production from stocked fry are based on work done on the R. Conon (3 smolts per 100m2). This would be equivalent to 6,000 smolts. 13% survival rate of stocked fed fry to smolt found at fed fry density of 32/100m2. (Would be 5,200 if using the 40,000 fry figure). Upper figure is halfway between stocked and wild estimate. Assume 50% survival rate parr to smolt for wild fish. | [5], [15], [6] |
| **Smolts at estuary** | 2,657- 4, 188 (smolts travel an average of 25km) | 6748 | **Stocked fish may migrate late and injure themselves negotiating the falls they were stocked above**. Missing Salmon Project found 46.5% of R. Conon smolts made it out of the river, compared with 49.2% average across all 7 Moray Firth rivers. Assume 49.2% for the Beauly (NB tagging method would affect survival too). 10% deducted from stocked fish for increased predation risk, and possible injury negotiating the waterfalls they were stocked above. | [12], [13], [14] |
| **Returned Salmon** | 93- 147 | 472 | Fed stocked fish more likely to smolt at 1+ and come back as grilse. Smaller smolt size contributes to **lower sea survival of hatchery raised fish**. Assuming a 7% return rate of wild fish, and 3.5% for stocked fish. | [3] |
| **Caught on the rod** | **9- 15** (minimum) | **47** (minimum) | Assume anglers catch 10% of returning adults. | [10] |

The estimate above suggests that between 1994- 2013, a minimum of 0.7-1.1% of rod catch may have been fish of stocked origin, compared to an equivalent minimum percentage of 3.5% for fish naturally spawned and reared in the river.

This assessment does not consider that brood stock removal meant that their contribution to natural spawning did not occur, nor the negative interactions that stocked fish have on the wild-born populations in terms of reduced population fitness and more long-term impacts. It has also been shown that the reproductive success of stocked origin fish is less than that of naturally reared fish [11], [7].

Adults stocked as fry above natural barriers are likely to spawn at the bottom of them, thereby genetically undermining the wild population found there over the long run. Stocking above natural barriers also causes changes to the natural ecosystems originally found there e.g. by depressing native trout populations. Further negative interactions are discussed in Marine Scotland’s summary.

**Parr calculation:**

The key consideration is that putting more juvenile fish into the river does not automatically result in an increase in returning adults. Whilst fry numbers can vary widely from site to site each year, the availability of parr habitat acts as a ceiling to the number of parr that are able to survive to smolt etc **If parr habitat is already ‘full up’ with wild parr (i.e. habitat is at carrying capacity) then there is no space/ food left for any additional stocked parr.** We currently do not know where we are on the ‘stock-recruitment curve’ and it would be good to know at what point reduction in adult return rate results in empty parr habitat (and reduced smolt output). From electro-fishing data it would appear things in the lower catchment are ok for now however it would be good to look at what juvenile numbers looked like following the Beauly’s lowest return of adults ever in 1999\*.

1) + 2): As parr stocking occurred in areas already containing existing wild parr it would be very tricky to come up with a visualisation (as completed for the fry) for what the parr stocking looked like in terms of area of river used, however, NBFT did a fin clipping study. Using a figure of 25,000 stocked parr, they came out with an estimated maximum contribution of **10 fish to the rod**. Although there were caveats to this study, other research from nearby catchments lent support to this estimate.

**Conclusion**

**The purpose of this briefing was to illustrate the potential difference between the past stocking output and the equivalent natural output. Overall, it suggests past stocking on the Beauly made little positive difference to rod catch, whereas the ‘natural hatcheries’ on the river produce a much better adult return. Additionally, taking the progeny of brood-stock and introducing them to different areas of the catchment (away from where their parents would have naturally spawned) is likely to have altered the genetic map of the catchment, thereby reducing the resilience of the Beauly’s salmon population.**

Recommendations:

\*-To see how the lowest return of adults (ever) in 1999 may have affected juvenile numbers.

-To plot adult fish count data against resultant parr numbers to help create a stock-recruitment curve for the Beauly.

-Smolt monitoring work in the Beauly catchment could improve the survival estimate.

-Keep working to improve habitat to increase carrying capacity of the catchment.

**References**:

**[1] Aprahamian. M et al (2004) Survival of stocked Atlantic salmon and coarse fish and an evaluation of costs. Fisheries Management and ecology 11(3-4):153-163.**

**[2] Araki et al (2008) Fitness of hatchery-reared salmonids in the wild. Evolutionary Applications 1: 342-355.**

**[3] Jonsson. B et al (1991) Differences in life history and migratory behaviour between wild and hatchery reared Atlantic salmon in nature, Aquaculture 98(1) 69-78.**

**[4] Marine Scotland Science (2020) Scientific considerations and risk management when considering stocking Atlantic salmon.**

**[5] McMenemy (1995) Survival of Atlantic Salmon fry Stocked at Low density in the West River, Vermont. North American Journal of Fisheries Management 15: 2.**

**[6] Mills, D.M. (1991) Ecology & Management of the Atlantic Salmon. Chapman & Hall.**

**[7] Milot et al (2013) Reduced fitness of Atlantic salmon released in the wild after one generation of captive breeding. Evolutionary Applications 6: 472-485.**

**[8] NBFT (2008) River Beauly Habitat survey**

**[9] NBFT (2012) Assessment of Contribution to the Lower Beauly Fishery of Stocked Autumn Parr**

**[10] NBFT (2015) Advice Relating to the Proposed Re-stocking of the main stem of the Lower River Beauly**

**[11] O’ Sullivan et al (2020) Captive-bred Atlantic salmon released into the wild have fewer offspring than wild-bred fish and decrease population productivity. Proc. R. Soc. B 287: 20201671.**

**[12] SCENE, University of Glasgow, Atlantic Salmon Trust: River Conon ‘Missing Salmon Project’ 2019 Report.**

**[13] Skilbrei O. T, et al (2010) Delayed smolt migration of stocked Atlantic salmon parr. Fisheries Management and Ecology. 17: 6, 493-500**.

**[14]** **Thorstadt E.B et al (2011). Aquatic nomads: the life and migrations of Atlantic salmon. Atlantic Salmon Ecology. p1-32. Wiley-Blackwell.**

**[15] Whalen K.G et al (2000) Cross Tributatry analysis of parr to smolt recruitment of Atlantic salmon (Salmo salar). Canadian Journal of Fisheries and Aquatic sciences 57:8.**