Background and details on selected issues

Many of the concerns I raised regarding discrepancies and errors in Gargan et al. (2016) have been addressed in the Correction published on 22 May 2024 (see https://www.int-res.com/abstracts/aei/v8/c_p675-689/). The text and tables included below expand on some of the remaining issues, which I raised in the main text of the Comment on Gargan at al. (2016).

Text S1. Sea age, length frequency distribution and spawning history of Tawnyard Lough sea trout kelts

In Table 4 of Gargan et al. (2016), the annual number and percentage of sea trout kelts ≥35 cm (fork-length) recorded is based on the total number of sea trout kelts recorded each year in 1985–1988, whereas this is not the case for many of the subsequent years, when only a percentage of all kelts were measured for fork-length.

The sea age distributions and the numbers of fish examined in Gargan et al. (2016) differ from the statistics published in O'Farrell & Whelan 1991 (see comparison in my Table A2). With regard to sea age distribution, there is very good agreement between O'Farrell & Whelan (1991) and Gargan et al. (2016) for 1985 and 1988, reasonable agreement for 1987 but poor agreement for 1986. This is difficult to explain because Gargan et al. (2016) aged 422 of the 1986 sea trout kelts (compared to 489 in O'Farrell & Whelan 1991) and only 242 of the 1988 sea trout kelts (compared to 610 in O'Farrell & Whelan 1991). Discrepancies between the findings of Gargan et al. (2016) and O'Farrell & Whelan (1991), for 1988 can be explained by the fact that only 39.7% of recorded kelts were aged by Gargan et al. (2016).

Table 4 of Gargan et al. (2016) includes additional discrepancies and errors which are not easily explained. The percentages of sea trout kelts >35 cm long for the years 1985–1988 are based on my original unpublished data / fork-length frequency distribution graphs — with the exception of the 1985 graph, which was included in O'Farrell et al. (1990) and O'Farrell (2004) — and are 44, 35, 43 and 49, respectively. If the same numbers of fish had been included in the calculation of the percentage of previous spawners (based on female maturation patterns for Tawnyard Lough sea trout taken on rod and line during the 1983–1985 angling seasons, when 24% of 0SW females, 81.8% of 1SW females and 100% of older sea age females were found to be maturing (O'Farrell 1986; Table S1 in Supplement 2 below) the percentage of previous spawners among 1SW and older fish (assuming males had the same maturation patterns as females) would have been 19, 16, 17 and 27 (Table S2 in Supplement 2) for the spawning years 1984–1987 (kelt census years 1985–1988), respectively, while Table 4 of Gargan et al. (2016) details 18, 17, 12 and 40 for each of those years. However, Gargan et al. (2016) apparently include only 242 of the 610 sea trout kelts recorded in 1988, and it is unclear why the other fish were excluded.

Estimating the overall percentage of previous spawners requires knowledge of male sea trout maturation patterns. A total of 55 rod-caught 0SW males from Tawnyard Lough were examined internally during the years 1983–1985, and 18 (32.7%) were found to be maturing (O'Farrell 1986). No information is available for older males from Tawnyard Lough. Thus, the maturation patterns of 0SW males and females in Tawnyard Lough are similar.

The final column of Table 4 of Gargan et al. (2016) details the percentage of sea trout kelts longer than 35 cm for each of the years 1985–2004 (1989 data missing), based on the total number of kelts measured for fork-length each year (see Fig. S1 in the Supplement to Gargan et al. (2016) for length frequency histograms for each year). In some years, relatively small numbers of sea trout kelts were measured for fork-length, e.g. in 1993 (132 of 332 kelts) and 2003 (75 of 962 kelts), again with no clear explanation for the chosen sample size and an assumption that the measured fish were representative of the entire sea trout kelt population.

Table 4 of Gargan et al. (2016) also details the number of sea trout kelts aged each year ('total no. of trouts'). Very low numbers of sea trout kelt were aged in most years after 1988, e.g. in 1993 (24 of 332 kelts) and 1996 (23 of 478). These low sampling numbers for 1990 to 2004 render the sea age distributions reported in Table 4 of Gargan et al. (2016) less meaningful than they could be if larger numbers of fish had been aged. Typically, older sea age kelts migrate downstream earlier than younger ones (O'Farrell unpubl. data), and it is therefore not possible to subsample and expect to obtain a representative sea age profile for sea trout kelts.

Gargan et al. (2016) failed to mention that a total of 149 sea trout kelts recorded at the Tawnyard trap during 1992 (16 fish) and 1993 (133 fish) were transported to the Burrishoole catchment as part of the sea trout broodstock programme. While these fish were included in the numbers of sea trout kelts recorded in 1992 and in 1993, their removal and subsequent loss of survivors to future sea trout kelt numbers has been ignored. In addition, the caveat of low sample sizes in many years and the resulting limited reliability of the data needs to be clarified.

Text S2. Sea trout egg deposition in the Tawnyard Lough sub-catchment of the Erriff River system

There are several aspects to the calculations of Gargan et al. (2016) which are of concern. Firstly, the sex ratio of sea trout used in the calculation of ova deposition was not specified. Secondly, the lengths of kelts used in calculations include the lengths of male sea trout and on average, male migratory salmonids tend to be longer than females of the same sea age. There is evidence for this for returning adult salmon derived from reared smolt on the River Shannon (Wilkins & O'Farrell 1996) who recorded mean fork-lengths of 62.4 cm and 71.2 cm for female and male 1SW salmon, respectively, and 79.0 cm and 93.2 cm for female and male 2SW salmon, respectively, returning to Parteen Hatchery. Thirdly, the lengths of sea trout which enter freshwater during the summer months (note that fecundity determinations made in the 1980s by O'Farrell et al. (1989) were carried out during the months August–October) are slightly longer when they return to sea during the months of March–April the following year. For example, the fork-lengths of 21 1SW rod-caught maturing female sea trout from the Erriff River and Tawnyard Lough in 1984 averaged 37.0 cm (95% CI 0.71), while the fork-lengths of 71 1SW female sea trout kelts recorded in the Tawnyard Lough trap in 1985 averaged 39.4 cm (95% CI 0.57). Accordingly, based on non-overlapping 95% CI, the 1985 Tawnyard Lough 1SW female kelts were significantly longer than those 1SW maturing females measured during the 1984 angling season. For the above reasons, the use of sea trout kelt lengths in the manner in which they were used in Gargan et al. (2016) should result in an overestimate of sea trout egg deposition in the Tawnyard Lough sub-catchment.

There have been two other estimates of sea trout ova deposition in the Tawnyard Lough sub-catchment. O'Farrell et al. (1989) examined commercial catches from the Killary Harbour draft-net fishery, rod catches from the Erriff Fishery and downstream trap catches from Tawnyard Lough and after considering the sex ratio, percentage maturation, fecundity and relative abundance of each sea age group, estimated the 1986 egg deposition at 252,140 from a spawning escapement of 745 fish. This estimate does not include sea trout taken on rod and line on Tawnyard Lough during the 1986 angling season.

A second estimate was published by Solomon (1998), who calculated the annual mean egg deposition for the Tawnyard Lough catchment at 257,705 for the years 1984–1987 using length frequency of kelts (1985–1988), sex ratio of 50% female for all sea age classes, 33.3% of females <35 cm and 100% of larger females maturing, linear length:fecundity relationship derived for Erriff sea trout in 1985 (O'Farrell et al. 1989) and an assumption of 70% overwinter survival of kelts.

While all three population fecundity estimates are in general agreement despite using different methodologies, Gargan et al. (2016) failed to specify any sex ratio in their estimate and included fish harvested during the angling season, which O'Farrell et al. (1989) and Solomon (1998) did not. All things considered, the methodology for Tawnyard Lough sub-catchment sea trout egg deposition estimation described in O'Farrell et al. (1989) is more robust than those deployed by Solomon (1998) and Gargan et al. (2016). While O'Farrell et al. (1989) and Solomon (1998) estimated sea trout population fecundity for the Tawnyard Lough sub-catchment for the years 1986 and 1984–1987, respectively, Gargan et al. (2016) extrapolated these population characteristics to include all years up to 2003 and assumed that sea trout maturation patterns and fecundity determined during the 1980s continued to apply. There is no evidence that this is the case. There has been a change in the fecundity of Atlantic salmon (*Salmo salar*) in the Erriff since the 1980s. In 1983, the ova from a total of 53 rod caught 1SW salmon ranging in length from 51.5-70.4 cm were counted (fork-length:fecundity plotted in Figure 17 of O'Farrell & Whelan 1984) and the mean fecundity determined from raw data to be 3586 (95% CI 329). In 2010/2011, the fecundity of 18 1SW salmon from the Erriff was determined from fish collected close to spawning time and the mean fecundity was found to be 2503 (de Eyto et al. 2015), which is 69.8% of the 1983 mean number.

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Additional tables

Table S1. Sex and maturation status of sea trout taken on rod and line on Tawnyard Lough during the years 1983–1985 (from Table 26 of O'Farrell 1986)

Year	Sea age	Number	No. females	% female	No. females maturing	% females maturing
1983 (n = 28)	0	16	6	37.5	2	33.3
	1	7	4	57.1	4	100.0
	2	2	1	50.0	1	100.0
	3	1	0	0	0	0
	4	2	2	100.0	2	100.0
1984 (n = 57)	0	31	18	58.1	3	16.6
	1	21	8	38.1	7	87.5
	2	3	1	33.3	1	100.0
	3	2	0	0	0	0
1985 (n = 93)	0	62	30	48.3	8	26.3
	1	21	10	47.6	7	71.4
	2	5	3	60.0	3	100.0
	3	4	4	100.0	4	100.0
	4	1	0	0	0	0
1983–1985 (n = 178)	0	109	54	49.5	13	24.0
	1	49	22	44.9	18	81.8
	2	10	5	50.0	5	100.0
	3	7	5	71.4	5	100.0
	4	3	2	66.6	2	100.0
Total		**178**	**88**	**49.4**	**43**	**48.8**

Table S2. Tawnyard Lough sea trout kelts 1985–1988: estimate of numbers (and percentages) of previous spawners (PS) assuming 24% for 1SW fish, 81.8% for 2SW and 100% for older fish) i.e. maturation patterns for female Tawnyard Lough sea trout also applied to males.

Sea Age	1985	1986	1987	1988
0	0	0	0	0
1	29	25	40	52
2	41	34	32	83
3	7	13	10	23
4	3	5	1	3
5	0	0	0	1
Total PS	80	77	82	163
% PS	19	16	17	27
N	412	499	489	610

Text S3. Nuances of sea trout in the West of Ireland

Sea trout and brown trout in sea trout producing catchments in the West of Ireland typically spawn in suitable stream habitats during the month of November — several weeks before Atlantic salmon spawn in similar habitat.

In these catchments some brown trout smoltify, typically at age 2 or 3, and migrate as **smolts** to sea, usually during the months of April and May.

Most of the survivors return to freshwater as immature fish during July and subsequent months of the same year, depending on freshwater flow conditions, and are variously termed finnock, harvesters, juniors and for scientific purposes **0SW (zero-sea-winter) fish**. They remain in freshwater over the winter (regardless of their maturation status) and return to the sea the following spring, usually before the smolt run. In the West of Ireland, these fish are typically referenced as **kelts**, regardless of their maturation status.

After spending <3 mo at sea these fish are termed **1SW (one-sea-winter) fish** — even though the vast majority probably spent their first post-smolt migration winter in freshwater. The majority are now maturing and will spawn during November.

Survivors repeat this annual cycle of events as they age. These fish are all previous spawners and depending on the number of winters which have elapsed since their first seaward migration are termed **2SW, 3SW, 4SW** fish etc.

Based on the internal examination of rod caught sea trout on Tawnyard Lough during 1983–1985, the following probably applies to West of Ireland sea trout in general and assumes the absence of differential mortality rates among maturing and immature sea trout:

- 0SW females: 24% maidens (maturing) and 76% immature
- 1SW females: 24% previous spawners, 58% maidens and 18% immature
- 2SW females: 82% previous spawners and 18% maidens
- 3SW and older sea trout: 100% previous spawners

<u>Technical notation</u> for ageing sea trout typically incorporates (1) freshwater age at smolthood (followed by a full stop, or sometimes a forward slash, as separator), (2) no. of winters completed since smolthood (in freshwater or at sea), and (3) no. of times the fish has spawned since smolthood. Thus, a fish aged as 2.1+2SM+ (5 yr old) migrated to sea as a 2 yr old smolt, spent the first post-migration winter in freshwater or less likely at sea as an immature fish and then spawned during 2 successive winters before returning to freshwater after completing a final spring / summer at sea. The '+' symbol indicates summer growth as evidenced by widely spaced circuli on the scales; SM means spawning mark.