Received: 2 February 2021 | Revised: 14 April 2021 | Accepted: 15 April 2021

DOI: 10.1111/fme.12491

ORIGINAL ARTICLE

Fisheries Management and Ecology WILEY

Drift diving: A quick and accurate method for assessment of anadromous salmonid spawning populations

Helge Skoglund[1] | **Knut Wiik Vollset**[1] | **Robert Lennox**[1] | **Øystein Skaala**[2] | **Bjørn Torgeir Barlaup**[1]

[1]Laboratory for Freshwater Ecology and Inland (LFI), NORCE Norwegian Research Centre, Bergen, Norway

[2]Insitute of Marine Research, Bergen, Norway

Correspondence
Helge Skoglund, Laboratory for Freshwater Ecology and Inland (LFI), NORCE Norwegian Research Centre, Nygårdsgaten 112, Bergen N-5008, Norway.
Email: hesk@norceresearch.no

Funding information
NORCE Norwegian Research Centre; Miljødirektoratet; Nærings- og Fiskeridepartementet

Abstract

The accuracy of drift diving surveys of Atlantic salmon, *Salmo salar* L. and sea trout, *Salmo trutta* L., was evaluated by comparing the abundance and size distribution with catches in a fish trap over 6 years in the River Etneelva, western Norway. The population count from drift diving accounted for on average 96.3% of the salmon in the trap after accounting for the catches during fishing. Size structure registered during drift diving corresponded with trap catches of salmon, but the number of small salmon (<3 kg) appeared to be somewhat underestimated, while large salmon (>7 kg) were overestimated in drift diving. For sea trout, the match between drift diving counts and trap registrations was poorer (average 76.3%), but may have been affected by the surveys being performed too late with regards to sea trout spawning time. The study illustrates the utility of drift counting for estimating the entire population of anadromous salmonids in a river.

KEYWORDS
Atlantic salmon, population census, Salmo salar, Salmo trutta, sea trout, snorkelling

1 | INTRODUCTION

Anadromous salmonids are under threat due to various anthropogenic impacts throughout their ranges. Sustainable management requires adequate information on population size and structures. Traditionally, stock assessment has been based on catch statistics from commercial and/or recreational fisheries (Friedland et al., 2009). While river specific catch data are often readily available for many rivers, the use is often limited as the catch reporting may be variable, and fishing effort is often unknown or spatially and temporally variable. Detailed data on population size and structure can be obtained from traps, counting fences or other installations that enable registration of fish ascending the rivers (Downton et al., 2001). However, such traps may be expensive to install and operate and may not be feasible to gather population data in a wide range of rivers.

Snorkelling surveys, also called drift diving, have become an increasingly popular method for quantifying riverine fish populations (Thurow et al., 2012; Weaver et al., 2014), including salmonids (Locke, 1997; Vollset et al., 2014). Drift diving has several advantages as it is a versatile, non-invasive and cost-effective method and thus applicable for large scale sampling of population data. In Norway, drift diving has become one of the most important methods for monitoring Atlantic salmon *Salmo salar* L. populations (Forseth et al., 2013) and presence of escaped farmed salmon (Glover et al., 2019; Mahlum et al., 2021), with more than 120 rivers surveyed in 2019.

Whereas several tests suggest that drift diving may both provide precise and accurate population estimates on Atlantic salmon, at least at the pool to reach scale (Mahlum et al., 2019; Orell & Erkinaro, 2007; Orell et al., 2011), the precision may vary depending on underwater visibility, focus species, experience level of personnel, habitat type, river size and fish size (Hagen & Baxter, 2005; Hillman et al., 1992; Locke, 1997; Orell & Erkinaro, 2007; Orell et al., 2011; Weaver et al., 2014; Young & Hayes, 2001). Consequently, drift diving precision in estimating whole river population size and structure may deviate from pool scale precision estimates. Despite the wide use of the method for quantifying Atlantic salmon populations, few tests have been performed with regards to the efficiency of the method on population level in larger and more complex river systems.

In the River Etneelva in Norway, ascending Atlantic salmon and anadromous brown trout *Salmo trutta* L. have been caught and registered in a resistance board weir trap in the lower end of the river since 2013. This creates a perfect design setup to test the precision of whole river snorkelling surveys of Atlantic salmon and sea trout, by comparing the trap registrations with subsequent drift diving after the adult run in the autumn. The goal of this study was, therefore, to compare estimates of population size and structure using a whole river trap and drift diving in a medium-sized river on the west coast of Norway.

2 | MATERIAL AND METHODS

2.1 | Study area

The study was performed in River Etneelva, located in the outer parts of the Hardangerfjord in western Norway. The river has a total drainage area of 252.5 km^2 and a median discharge of 23.4 m^3/s. The river system constitutes two main tributaries (Nordelva and Sørelva), which have a confluence ≈3.5 km upstream from the river outlet (Figure 1). The river reach that is available for anadromous fish covers a total length of 28 km, including two lakes (Stordalsvatnet and Litledalsvatnet) that constitute about 50% of the anadromous reach. The river system has self-sustaining populations of Atlantic salmon and anadromous brown trout.

2.2 | Fish trap

A resistance board weir trap is installed in the lower reaches of the river, about 1 km upstream the outlet in the sea (Figure 1). The trap

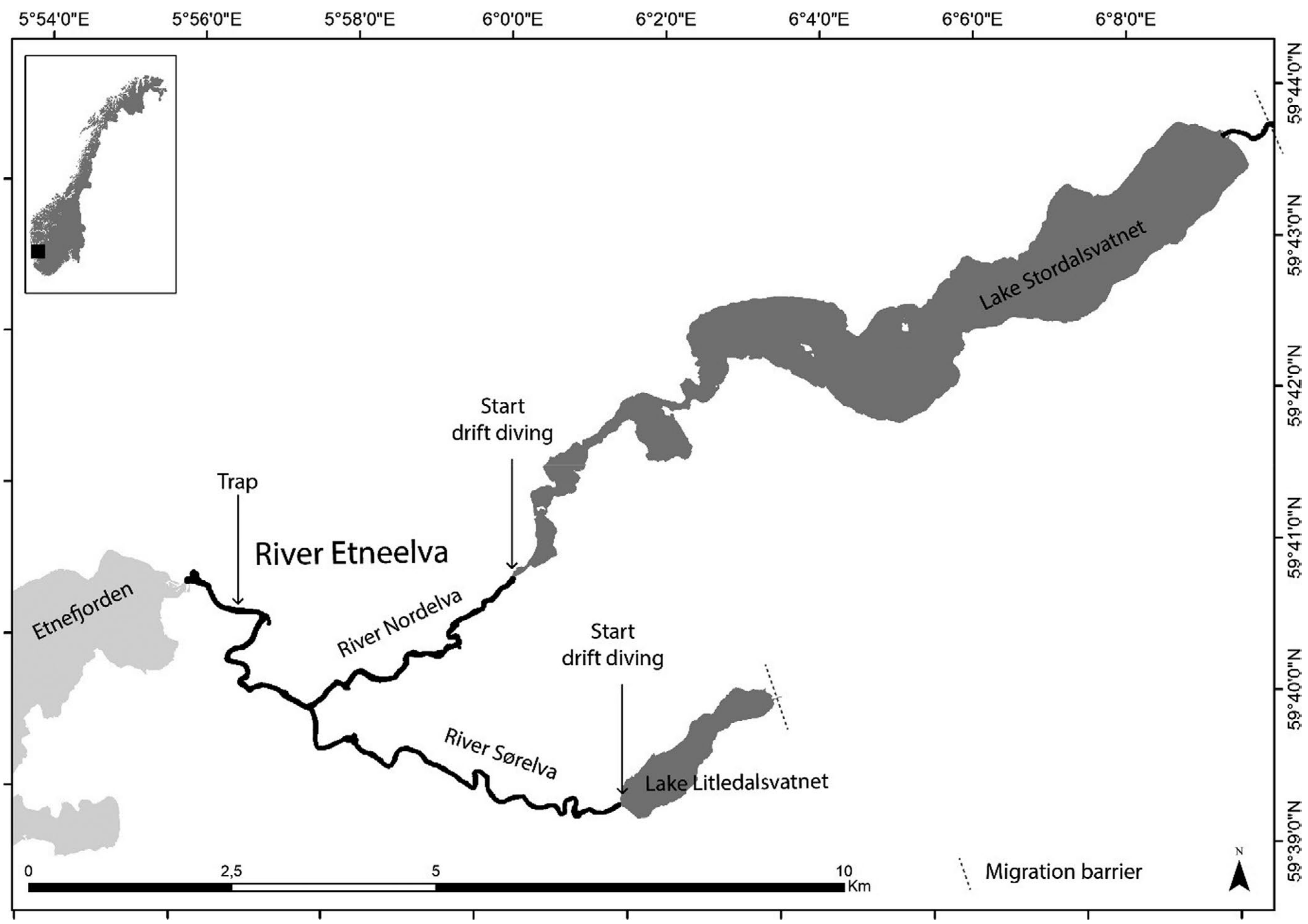

FIGURE 1 Map showing the distribution of Atlantic salmon and sea trout in the watershed of River Etneelva. The anadromous river reaches are indicated in black, and the arrows indicate the starting points of drift diving and the location of the trap

TABLE 1 Atlantic salmon and sea trout of different size classes registered in the trap (before drift diving), catches of fish removed during fishing and numbers observed during drift diving above the trap

	Atlantic salmon					Sea trout				
	Total	<3 kg	3–7 kg	>7 kg	Farmed	Total	<1 kg	1–2 kg	2–3 kg	>3 kg
Trap										
2013	1125	441	558	126	67	932	221	454	166	91
2014	411	177	180	54	160	364	72	133	125	34
2015	2067	1212	733	122	185	1073	204	452	249	168
2016	2114	561	1421	132	127	1052	213	417	254	168
2017	1900	594	1013	293	80	–	–	–	–	–
2018	1539	528	863	148	79	797	221	239	214	123
2019	1210	541	521	148	47	1236	524	409	135	168
Catch during fishing above trap										
2013										
2014	0	0	0	0	–	0	–	–	–	–
2015	0	0	0	0	–	0	–	–	–	–
2016	584	136	408	40	–	3	–	–	–	–
2017	448	89	270	89	–	33	–	–	–	–
2018	175	51	108	16	–	0	–	–	–	–
2019	210	71	110	29	–	3	–	–	–	–
Drift diving above trap										
2013	746	192	460	94	7	533	152	267	78	36
2014	509	190	256	63	21	414	230	132	40	12
2015	1737	1033	576	128	4	1015	307	410	190	108
2016	1524	264	963	297	6	684	150	253	174	107
2017	-	–	–	–	–	–	–	–	–	–
2018	1023	276	573	174	7	604	144	207	125	128
2019	1067	447	435	185	6	668	134	268	162	104

Note: Escaped farmed salmon (Farmed) is not included in the total numbers, and all farmed fish caught in the trap was sorted out and euthanised. There was no fishing in 2014 and 2015, and for sea trout size data in catches was not available.

is 40 m wide and covers the entire cross section of the river (see Harvey et al. (2017) for further description of the trap). The trap was operated from April to November from 2013 to 2019, which covers the main migration period for salmon and trout, and was checked daily for ascending fish. All fish caught were registered by species, length, weighted and sampled for scales, and tissue samples were taken from the adipose fin (for DNA). All wild salmon and sea trout were released above the trap, whereas escaped farmed salmon was sorted out based on appearance and euthanised. Origin (wild or farmed) was later confirmed based on scale analyses. While the trap is highly effective for fish >30 cm, smaller sea trout will pass undetected through the floating barrier, and occasionally larger fish may also pass (upstream or downstream) during flooding episodes. The trap efficiency has not been investigated systematically throughout the period, but, based on recordings of sampling marks (small cut on the adipose fin from DNA sampling) on fish sampled above the trap, the overall efficiency is approximately 90% for wild salmon (Ø. Skaala unpublished data).

2.3 | Drift diving

Drift diving has been performed in River Etneelva over the period 2004–2019, with the exception of 2017, when high-flow conditions precluded snorkelling. Drift diving was also planned in 2020 but was cancelled due to poor underwater visibility. The field work was performed during periods of low flow in October or November, prior to or during the spawning period for salmon. Drift diving has been performed from the outlet of the lakes Stordalsvatnet in Nordelva and Litledalsvatnet in Sørelva, downstream to the river mouth, which covers a river reach of 12 km, containing the main spawning reaches for salmon in the River Etneelva (Figure 1). The counts were performed by teams of 2–4 personnel snorkelling in parallel depending on the size of the river. Only one person counted parts of the tributary Sørelva, when conditions allowed. To avoid multiple registrations of fish, the team only counted fish passing in the upstream direction. The snorkelers stopped at regular intervals, typically at the tails of each pool or after predefined observation zones, to coordinate the observations and write them down on a waterproof notebook. Each fish (only adult spawning fish) was visually identified to species (Atlantic salmon or brown trout) and size class based on visually estimated weight (salmon: <3 kg, 3–7 kg and >7 kg; sea trout: <1 kg, 1–2 kg, 2–3 kg, >3 kg). In addition, visually identifiable characters of origin (wild or farmed) were registered.

2.4 | Data analysis

The aim of the analysis was to compare the number and structure of catches in the resistance board weir trap with drift diving counts. To get comparable numbers several aspects need to be considered. Sport fishing and broodstock fishing were conducted in the whole river during the survey period. Therefore, to compare drift diving numbers to trap numbers, catches must be subtracted. However, the official catch statistics (Statistics Norway or SSB) also include catches below the trap (fishing zones 1 and 2). To correct this, local registrations of catches in zone 1 and 2 were subtracted from the catch statistics before subtracting this number from the catches in the trap. To compare size structure, the data were lumped into the coarse categorisation defined by the drift diving survey, that is small >3 kg, medium 3–7 kg and large <7 kg, and corrections were done for each size category. Fishing was closed in the river in 2014 and 2015, so no correction was made for these two years. Similar corrections were made for sea trout, although sea trout are protected and no sport fishing was conducted during the whole period. However, unintentional catches have occurred during years when fishing for salmon and were corrected when reported. To provide information about trap efficacy, catches of farmed salmon caught in the trap (available from www.etnelaks.no) were compared with observations of farmed fish observed above the trap.

Statistical analysis was done using simple general linear regression between corrected counts in the trap and counts in the drift diving surveys. Counts have by definition a Poisson distribution, but, because the numbers are far from zero (as in the present study), residuals were distributed according to Gaussian distribution. Therefore, a simple Gaussian linear model was used where the corrected R^2 was reported to describe the per cent of the variance in the corrected trap data that were explained by the drift diving counts. To evaluate the precision of the size groups, separate linear models for the different size groups were carried out and reported based on the variance explained for each group. To test for whether the correlation between drift diving counts and trap catches deviated from the 1:1 line, a model was built where the number of fish caught in the trap was set as an offset, which would yield a p-value for the hypothesis test about a 1:1 relationship.

3 | RESULTS

Total fish registered by the trap ranged from 411 to 2114 salmon and 364 to 1236 sea trout prior to drift diving in the different study years (Table 1). Among these, 0–584 salmon and 0–33 sea trout were caught during sport fishing or removed as brood stock prior to drift diving. In drift diving, there were 509–1737 salmon and 414–1015 sea trout registered in the corresponding years (Figure 2). In addition to wild salmon and sea trout, 47–185 escaped farmed salmon were trapped and removed from the trap prior to drift diving, and 4–21 farmed fish were observed above the trap during drift diving counts, suggesting that the trap had a catch efficiency between 88% and 98% with regards to escaped farmed salmon during the study period.

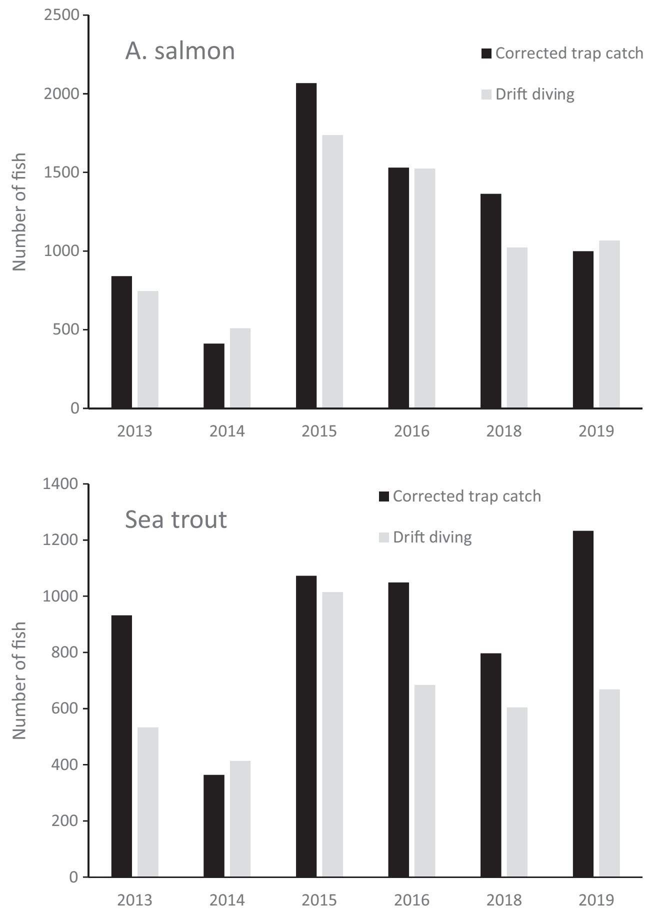

FIGURE 2 Number of Atlantic salmon (upper) and sea trout (lower) caught in the trap (corrected for catches upstream the trap) and observed during drift diving in the different years of the study

After accounting for fish removed during fishing, the number of salmon observed during drift diving was significantly related to the numbers registered in the fish trap (Figure 3, R^2 = 0.89, $F_{1,5}$ = 42.4, p < 0.01). On average, drift diving accounted for 96.3% of the population registered in the trap, ranging from 75.0% to 123.8% among years. The relationship did not deviate from the 1:1 line (t = 1.282, p = 0.26).

For sea trout, the correspondence between drift diving and trap catches was poorer than for salmon (Figure 4, R^2 = 0.28, $F_{1,5}$ = 3.0, p = 0.16), and drift diving accounted on average for 76.8% (range: 54.2%–113.7%) of the population registered in the trap. The relationship also deviated from the 1:1 line.

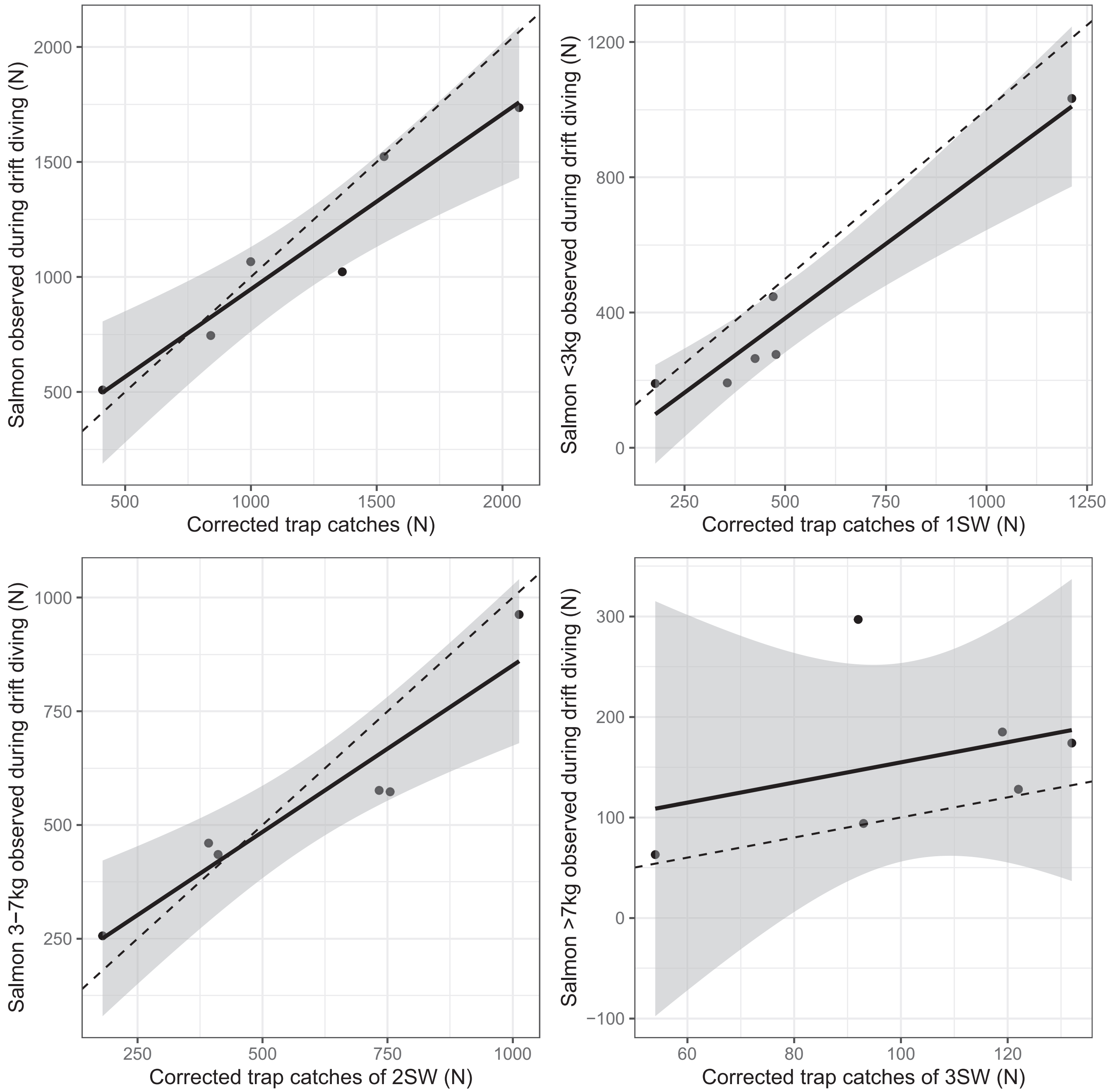

FIGURE 3 Comparison of total numbers and numbers salmon in different size classes of Atlantic salmon caught in the trap (corrected for fishing above the trap) and from observations during drift diving. The broken line indicates the 1:1 relationship

In general, the size distribution of salmon classified during drift diving corresponded well with registration in the trap (Figure 3). The numbers of both small (<3 kg) and medium-sized salmon (3–7 kg) in drift counts were significantly correlated with the trap catches (small: $R^2 = 0.92$, $F_{1,5} = 62.5$, $p < 0.01$; medium: $r^2 = 0.87$, $F_{1,5} = 33.6$, $p < 0.01$), while the number of large salmon in the drift count correlated poorly with trap registrations ($r^2 = 0.1$, $F_{1,5} = 0.5$, $p = 0.5$). The number of small salmon tended to be somewhat lower, whereas large salmon tended to be higher in the drift count than recorded in the trap.

For sea trout, the relationship between classifications in the drift dive and the number registered in the trap varied among the size classes (Figure 4, sea trout <1 kg: $r^2 = 0.01$, $F_{1,5} = 1.1$, $p = 0.34$; 1–2 kg: $r^2 = 0.58$, $F_{1,5} = 8.0$, $p = 0.04$; 2–3 kg: $r^2 = 0.35$, $F_{1,5} = 3.7$, $p = 0.13$; >3 kg: $r^2 = 0.67$, $F_{1,5} = 11.2$, $p = 0.028$).

4 | DISCUSSION

Snorkelling censuses by drift diving provide a versatile and cost-effective method for surveying riverine salmonids populations, but the precision and accuracy of the method for population-level surveys in larger river systems are unknown. Here, data from drift diving performed above a fish trap in River Etneelva, a moderately large

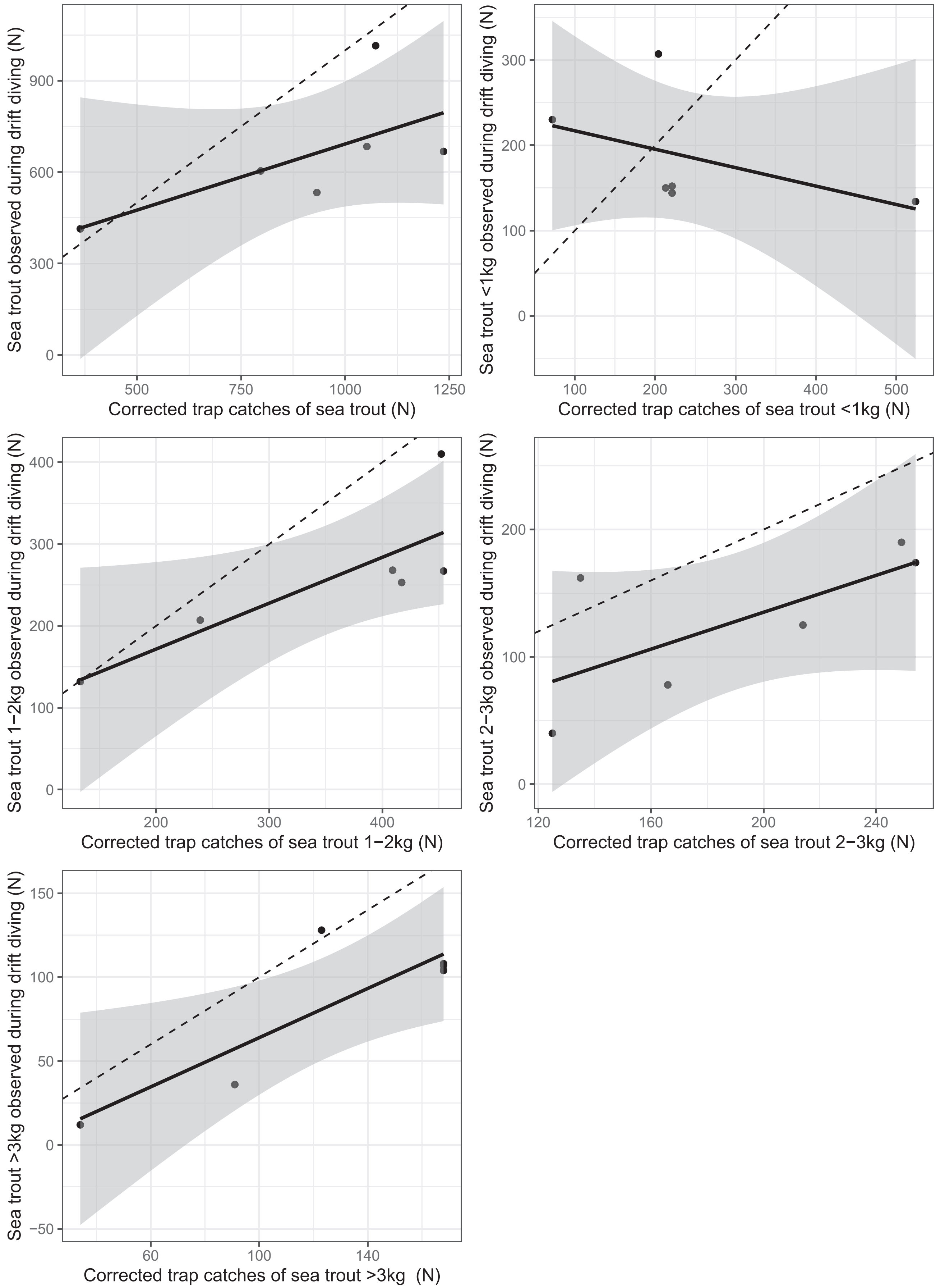

FIGURE 4 Comparison of total numbers and number of sea trout in different size classes caught in the trap (corrected for fishing above the trap) and from observations during drift diving. The broken line indicates the 1:1 relationship

river system in western Norway containing a variation of habitat types, including lakes, rapids, glides and pools, are provided. During the six years where data exist from both sources, population counts from drift diving on average accounted for 96.3% of the salmon in the trap after accounting for the catches during fishing. This result complements previous studies showing that drift diving may provide accurate data on salmon population size at pool/site (Mahlum et al., 2019) and reach levels (Orell et al., 2011).

While the size structure registered during drift diving in general corresponded well with the size structure of salmon in the trap, the number of small salmon appeared to be somewhat underestimated, while large salmon were overestimated in drift dive compared with the registrations in the trap. Estimating fish size under water may, in some cases, be challenging, as the perceived fish size may depend on distance, and refraction in the snorkelling mask typically makes objects look closer and larger under water. Furthermore, fish that are close to the size categories boundaries (i.e. near 3 and 7 kg) are likely to be particularly prone to misclassification. It is also possible that size bias may, at least in part, be attributed to larger fish being easier to spot than smaller fish, thus resulting in underestimating in total numbers of the small salmon. It is not clear whether this is a general pattern during drift diving, as a similar pattern was not found by Mahlum et al., (2019) method testing at the pool scale by the same core team of snorkelers.

As drift diving is based on visual identification of fish, it is crucial that the survey is conducted during appropriate conditions for underwater observations, and with sufficiently experienced personnel. Water clarity is usually the main limiting factor, and the method is typically only applicable in clear-water rivers and during periods of low flow conditions (Mahlum et al., 2021; Orell et al., 2011). This may impose restriction on the river types and time period available for performing drift diving. In the present study period, drift diving in River Etneelva had to be cancelled due to high flow and poor visibility in two out of eight years in the study period. The precision level may also depend on river size and habitat types. Orell and Erkinaro (2007) found that detection frequency was higher in pools than in rapids, and higher in smaller than larger rivers. Detection frequency in different habitats and river types was, however, likely to depend on the experience level of the drift diving crew (Orell et al., 2011), as it requires skill to detect and correctly identify fish under varying conditions. For example, fish may display different behavioural patterns upon encounter, such as hiding or fleeing, and it is pivotal that the drift diving crew is well organised and approaches the fish in a controlled way that allows for adequate registration. Yet, some fish may hide under or in between boulders or in habitats where they stay hidden from experienced snorkels, or in rapids that are unsafe for snorkelling. In addition, care is usually taken to avoid multiple counts of fish and avoid possible overestimation of the population. Consequently, drift diving is in many cases expected to underestimate the total number of fish and thus likely to give a conservative estimate of population size.

For sea trout, the match between drift diving and trap registrations was poorer with regards to total population size, precision among years and size composition. This may in part be due to the census in this case being conducted with the main focus being on Atlantic salmon, resulting in poorer data quality for sea trout. For example, sea trout typically spawn one to three weeks earlier than Atlantic salmon inhabiting the same river (Heggberget et al., 1988), and the census was in several of the years in this study performed after the sea trout had abandoned the spawning areas. Also, sea trout will, to a greater extent, spawn in smaller tributaries than salmon (Klemetsen et al., 2003), and a part of the sea trout population may, therefore, have resided in the tributaries that were not included in the survey. Furthermore, as sea trout generally are smaller, they are typically less conspicuous and may seek shelter under rocks or in vegetation easier, and hence avoid detection during drift diving. It is feasible to obtain higher precision for sea trout if the drift diving is conducted at a time that better matches with the spawning period of sea trout, and also by including the most important tributaries. Optimising precision of counting will depend on having information about the timing of sea trout and salmon spawning and whether there are anadromous lakes in the system where fish can reside before spawning and be unavailable to counts (Lennox et al., 2021).

A caveat in the present study is the efficiency of the trap, as fish occasionally may migrate past the trap without being registered. The trap was designed to reduce the influence of escaped farmed fish entering the river, and drift diving above the trap confirms that a few escapees passed the trap unrecorded. The efficiency of the trap appears to be related to peak flows, such as in 2014 when the water discharge rose to over 150 m^3/s following ascent of farmed salmon after an escape incidence from an aquaculture site in the fjord system near River Etneelva. Based on the number of farmed fish observed during drift diving, the trap efficiency with regards to removal of farmed fish appears to be between 88% and 98% during the study period. A trap efficiency of about 90% or higher is also consistent with the samples of wild salmon from the spawning grounds that had been marked after sampling from the trap (small cut in adipose fin for DNA, Ø. Skaala unpublished data). The two years with the lowest apparent efficiency with regards to farmed salmon (i.e. in 2014 and 2019) were also the two years when the wild salmon counts from drift diving were higher than the trap catches, suggesting that the discrepancy in these two years was caused by lower trap efficiency rather than drift diving counts being overestimated. Overall, although the true accuracy in drift diving may be slightly lower than suggested from the direct comparisons with the trap catches, the effects are likely to be minor and not affect the conclusion of the study.

This study provides important data for evaluation of the drift diving method for an entire salmonid population including multiple species. Having a fish trap facilitated a comparison with another established method of enumeration, but, while fish traps may provide very precise data on a number of variables such as timing of ascendance, size of individuals, recapture of tagged individuals and physical material such as scale samples for age- and growth analyses and genotyping to address a number of genetic issues, fish traps are resource intensive. Therefore, alternative methods such as drift counting are greatly needed for tracking population trends and informing management efforts for anadromous salmonids. Presently, drift diving is best developed for Atlantic salmon, but it can also be useful for sea trout populations. Validations for other anadromous salmonids, for example Pacific salmon, would be useful to evaluate how accurate this method is for different species. Although the application is limited to clear-water streams and rivers, it offers a cost-effective tool for providing population data from a wide range of rivers and is used for evaluating river specific spawning targets and catch efficiency of rod fishing (Forseth et al., 2013). Furthermore, drift diving may also provide credible data on escaped farmed salmon in rivers (Mahlum et al., 2019) and is one of several methods used for long-term monitoring of escaped farmed salmon in Norwegian rivers (Glover et al., 2019). The current research illustrates the utility of drift counting for estimating the entire population of anadromous salmonids in a river and provides a template for further evaluations in rivers of different size, clarity and complexity throughout the range of anadromous salmonids.

ACKNOWLEDGMENTS

We would like to thank Tore Wiers, Eirik Straume Normann and the other staff at NORCE LFI that have contributed on drift diving, Sebastian Stranzl for providing map and Per Tommy Fjeldheim for preparing data from the fish trap. The snorkelling surveys were financed by the Norwegian Environment Agency, whereas the operation if the trap is financed by the Ministry of Trade, Industry and Fisheries, and OURO. The analyses and preparation of the manuscript was funded internal strategic resources (basic funding) by the NORCE Norwegian Research Centre.

ORCID

Helge Skoglund https://orcid.org/0000-0003-4303-6292

REFERENCES

Downton, P.R., Reddin, D.G. & Johnson, R.W. (2001) *Status of Atlantic salmon (Salmo salar L.) in Campbellton River, Notre Dame Bay (SFA 4), Newfoundland in 2000*. CSAS, Canadian Science Advisory Secretariat= SCCS, Secrétariat canadien de consultation scientifique.

Forseth, T., Fiske, P., Barlaup, B., Gjøsæter, H., Hindar, K. & Diserud, O.H. (2013) Reference point based management of Norwegian Atlantic salmon populations. *Environmental Conservation*, *40*(4), 356–366.

Friedland, K.D., MacLean, J.C., Hansen, L.P., Peyronnet, A.J., Karlsson, L., Reddin, D.G. et al. (2009) The recruitment of Atlantic salmon in Europe. *ICES Journal of Marine Science*, *66*(2), 289–304.

Glover, K.A., Urdal, K., Næsje, T., Skoglund, H., Florø-Larsen, B., Otterå, H. et al. (2019) Domesticated escapees on the run: the second-generation monitoring programme reports the numbers and proportions of farmed Atlantic salmon in>200 Norwegian rivers annually. *ICES Journal of Marine Science*, *76*(4), 1151–1161. https://doi.org/10.1093/icesjms/fsy207

Hagen, J. & Baxter, J.S. (2005) Accuracy of diver counts of fluvial rainbow trout relative to horizontal underwater visibility. *North American Journal of Fisheries Management*, *25*(4), 1367–1377.

Harvey, A.C., Tang, Y., Wennevik, V., Skaala, Ø. & Glover, K.A. (2017) Timing is everything: Fishing-season placement may represent the most important angling-induced evolutionary pressure on Atlantic salmon populations. *Ecology and Evolution*, *7*(18), 7490–7502.

Heggberget, T.G., Haukebø, T., Mork, J., & Ståhl, G. (1988). Temporal and spatial segregation of spawning in sympatric populations of Atlantic salmon, Salmo salar L., and brown trout, Salmo trutta L. *Journal of Fish Biology*, *33*(3), 347–356. https://doi.org/10.1111/j.1095-8649.1988.tb05477.x

Hillman, T.W., Mullan, J.W. & Griffith, J.S. (1992) Accuracy of underwater counts of juvenile chinook salmon, coho salmon, and steelhead. *North American Journal of Fisheries Management*, *12*(3), 598–603.

Klemetsen, A., Amundsen, P.A., Dempson, J.B., Jonsson, B., Jonsson, N., O'connell, M.F. & et al. (2003) Atlantic salmon Salmo salar L., brown trout Salmo trutta L. and Arctic charr Salvelinus alpinus (L.): a review of aspects of their life histories. *Ecology of Freshwater Fish*, *12*(1), 1–59.

Lennox, R.J., Pulg, U., Malley, B., Gabrielsen, S.E., Hanssen, E.M., Cooke, S.J. et al. (2021) The various ways that anadromous salmonids use lake habitats to complete their life history. *Canadian Journal of Fisheries & Aquatic Sciences*, *78*(1), 90–100.

Locke, A. (1997) Precision of diving and canoe-based visual estimates of Atlantic salmon (Salmo salar) abundance. *Fisheries Research*, *29*(3), 283–287.

Mahlum, S., Skoglund, H., Wiers, T., Norman, E.S., Barlaup, B.T., Wennevik, V. et al. (2019) Swimming with the fishes: validating drift diving to identify farmed Atlantic salmon escapees in the wild. *Aquaculture Environment Interactions*, *11*, 417–427.

Mahlum, S., Vollset, K.W., Barlaup, B.T., Skoglund, H. & Velle, G. (2021) Salmon on the lam: Drivers of escaped farmed fish abundance in rivers. *Journal of Applied Ecology*, *58*, 550–561.

Orell, P. & Erkinaro, J. (2007) Snorkelling as a method for assessing spawning stock of Atlantic salmon. *Salmo salar. Fisheries Management and Ecology*, *14*(3), 199–208.

Orell, P., Erkinaro, J. & Karppinen, P. (2011) Accuracy of snorkelling counts in assessing spawning stock of Atlantic salmon, Salmo salar, verified by radio-tagging and underwater video monitoring. *Fisheries Management and Ecology*, *18*(5), 392–399.

Thurow, R.F., Dolloff, C.A. & Marsden, J.E. (2012) Visual observation of fishes and aquatic habitat [Chapter 17]. In: Zale, A.V., Parrish, D.L. & Sutton, T.M. (Eds.), *Fisheries techniques*, 3rd edition, pp. 781–817. Bethesda, MD: American Fisheries Society.

Vollset, K.W., Skoglund, H., Barlaup, B.T., Pulg, U., Gabrielsen, S.-E., Wiers, T. et al. (2014) Can the river location within a fjord explain the density of Atlantic salmon and sea trout? *Marine Biology Research*, *10*(3), 268–278.

Weaver, D.M., Kwak, T.J. & Pollock, K.H. (2014) Sampling characteristics and calibration of snorkel counts to estimate stream fish populations. *North American Journal of Fisheries Management*, *34*(6), 1159–1166.

Young, R.G. & Hayes, J.W. (2001) Assessing the accuracy of drift-dive estimates of brown trout (Salmo trutta) abundance in two New Zealand rivers: A mark-resighting study. *New Zealand Journal of Marine and Freshwater Research*, *35*(2), 269–275.

How to cite this article: Skoglund H, Vollset KW, Lennox R, Skaala Ø, Barlaup BT. Drift diving: A quick and accurate method for assessment of anadromous salmonid spawning populations. *Fish Manag Ecol*. 2021;00:1–8. https://doi.org/10.1111/fme.12491