Migration season of whitebait of giant kokopu, *Galaxias argenteus*

R M McDowall
National Institute of Water & Atmospheric Research
PO Box 8602
Christchurch

Published by
Department of Conservation
Head Office, PO Box 10-420
Wellington, New Zealand

This report was commissioned by West Coast Conservancy.

ISSN 1171-9834

Reference to material in this report should be cited thus:

McDowall, R.M., 1999.
Migration season of whitebait of giant kokopu, *Galaxias argenteus. Conservation Advisory Science Notes No. 263,* Department of Conservation, Wellington.

Keywords: Whitebait species, giant kokopu, *Galaxias argenteus*, migration season, West Coast, Southland.

Abstract

Sampling of whitebait from the migrations in a series of West Coast and Southland rivers (Heaphy, Orowaiti, Buller, Hokitika, Wanganui, Okarito, Mataura) showed that whitebait of the giant kokopu migrate late in the spring, beginning to enter rivers during early November and continuing well through December. Amongst 70 whitebait samples containing nearly 9000 whitebait there were only 231 giant kokopu whitebait, all of these taken later than 4 November. All but 4 of the giant kokopu whitebait present in samples were taken from the Buller and Hokitika Rivers; this is due in large measure to the fact that it was from these two rivers that most samples taken during November and December were taken.

1. Introduction

The larval and juvenile life stages of the giant kokopu, *Galaxias argenteus* (Gmelin), are spent at sea. The juveniles return to river mouths in the spring as part of the New Zealand whitebait fishery (McDowall 1984), though they form only a very small proportion of the fish taken in the fishery (McDowall & Eldon 1980). Very little is known about the whitebait stage of the giant kokopu owing to its relative rarity in the fishery, though there has been estimation of age at migration, and from this prediction of the spawning season (McDowall et al. 1994, McDowall & Kelly 1999). The season of migration by this species was suggested as early to mid November, with most being taken from 6-8 November onwards (McDowall & Eldon 1980). This conclusion was based on all captures of giant kokopu from diverse West Coast rivers over a period of 5 years (1969-1973). During this period a total of 194 giant kokopu were identified from over 2400 whitebait samples containing hundreds of thousands of whitebait from West Coast rivers from the Buller in the north to the Cascade River in the south. Seasonal distribution of the capture of these giant kokopu is shown in Fig. 1.

Data indicating that most giant kokopu whitebait migrate after about the end of the first week of November formed the basis for the Department of Conservation implementing control measures on the West Coast whitebait fishery with the intention of providing additional protection of giant kokopu, since this species is regarded as threatened (Tisdall 1994). Regulations were introduced to close the whitebait fishing season after the end of October, on the grounds that this would minimise capture of giant kokopu whitebait. It was considered that the closure of the fishery after 31 October, rather than after 14 November, would not result in too severe curtailment of fishing and reduction of catch since only a small proportion of whitebait is usually taken during November - subsequent analysis (McDowall 1994) suggested that, in most years, less than 10 % of the seasonal catch has been taken in the period 1-14 November. Whitebait fishers objected strenuously to curtailment of fishing, and sought a revocation of the new season closure date and a restoration

of the 14 November closure. The matter came before the Regulations Review Committee of the New Zealand Parliament, and the Committee supported the stance adopted by the whitebait fishers, recommending restoration of the date of closure to 14 November (Northey 1994). This was done.

One of the points raised by the whitebaiters, in defence of their position, was that the information upon which closure was justified (that most capture of giant kokopu is after early November) was, by 1993, of some age (c. 20 years), and that it could therefore not be relied upon. Why the migration season of giant kokopu should be any different in 1993 from what it was in the late 1960s and early 1970s was not addressed. The West Coast Whitebaiters Association suggested that a sampling programme should be instituted to reinvestigate the question of the seasonal occurrence of giant kokopu whitebait and agreed to cooperate in conducting this sampling programme. The programme was instituted in 1996 and continued through the 1998 season at varying levels of intensity, and this report outlines the results of the sampling.

2. Materials and methods

Sampling of whitebait catch for this study was instituted in the spring of 1996. Sampling in that year was intended to cover the Buller, Hokitika, and Wanganui (West Coast) Rivers, to which the Mataura River (Southland) was added as a result of an offer to assist with sampling from the Southland Whitebaiters Association. During the 1997 season, samples were obtained from the Heaphy, Orowaiti, Buller, Hokitika, and Mataura Rivers, and in 1998 from the Buller and Hokitika Rivers. Samples were caught using nets of the various conformations typically used in the whitebait fishery (McDowall 1984).

The plan was to preserve samples of up to 250 grams of whitebait taken from catches every two or three days, or otherwise as often as these were available. As the sampling programme depended on the activities of whitebait fishers, sampling frequency and regularity depended on fisher activity, which was governed to some extent by the condition of the rivers. The springtime in western and southern New Zealand is a time of unstable weather conditions, and flooding of the rivers is frequent. These various factors meant that sampling frequency tended to be erratic. Although the fishing season (following restoration to the traditional season after curtailment in 1993) extends to 14 November, through an arrangement between the Department of Conservation and the West Coast Whitebaiters Association, permission was granted to allow experimental fishing beyond 14 November, and some sampling was undertaken through until almost the end of December.

Whitebait samples were preserved in 70% ethanol to allow later extraction of otoliths for ageing of whitebait (McDowall & Kelly 1999). Fish were identified according to the protocols described in detail in McDowall & Eldon (1980). Identification of the whitebait stages of the various species is difficult - so difficult that at present there are no objective criteria which enable the whitebait of koaro (*Galaxias brevipinnis)* to be distinguished from that of shortjaw

kokopu (*G postvectis*). The rarity of shortjaw kokopu (Tisdall 1994) suggests that its whitebait is likely also to be rare in the fishery, so that misidentification of shortjaw whitebait, apart from the drawback of preventing an understanding of the factors that affect its migration, has only the effect of slightly distorting (increasing) the numbers of koaro whitebait recorded. In brief, the following procedure is used in identification:

- Whitebait of inanga (*G. maculatus*) are sorted out first, as they are usually the most abundant and also the most easily identified from a combination of: larger size (though this varies seasonally and geographically), the presence of large black dots along the back anterior to the dorsal fin, the origins of the dorsal and anal fins being directly opposite, and a small mouth.

- Typically the remnant of samples comprises two size groups; the larger of these are koaro, identified most explicitly by a distinctly receding lower jaw and the origin of the anal fin being distinctly posterior to the origin of the dorsal fin;

- The smaller fish are banded kokopu (*G. fasciatus*), distinguished also by having the lower jaw only slightly receding and the origins of the dorsal and anal fins being directly opposite.

- Usually there is no great difficulty in an experienced observer distinguishing these two size/character groups; however, occasionally there are fish that seem to fall between the two size groups, and this alerts the observer to the presence of giant kokopu; because of the indeterminate identity based on size, much closer examination is required, and this draws attention to the key distinguishing feature of giant kokopu: viz. a long, flattened snout and a large mouth that reaches back well below the eyes. Once recognised, this character is highly distinctive.

This array of characters may seem subjective, and there is certainly an "art" in identifying the various species that is refined by experience. It is not easy, and is compounded by a series of variables that apply to all species. There is intraspecific variation both seasonally and geographically in size at migration. And there is also ontogenetic variation in form and pigmentation, as fish that have been in fresh water for longer change in shape and start to develop pigmentation patterns. Despite these differences, experienced observers have little uncertainty in identifications, apart from the problems in distinguishing koaro and shortjaw kokopu, mentioned above.

3. Results and discussion

Samples contained a total of 231 giant kokopu, all of these being taken after 31 October in any year. Therefore, in sample identification results presented in Table 1, only those samples taken after that date are listed (70 samples containing a total of 8844 whitebait). No samples from either the Wanganui

or Mataura Rivers were dated later than 31 October, and data from these rivers were not considered further. Thus giant kokopu whitebait constituted a very small proportion of the fish taken (2.1 % of fish taken after 31 October). Samples from only four days (all Hokitika River) contributed 152 of the total catch of giant kokopu (65.8 %), and two consecutive days (11-12 December, 1997) contributed 112 fish (48.5 %).

Numbers of giant kokopu caught thus fluctuated greatly from day to day. Reasons for these fluctuations are unknown, though those observed in the present sampling programme are no different from the sorts of fluctuations in species composition reported by McDowall & Eldon (1980) from a very much greater sampling programme.

One distinctive feature of the present programme is the continuation of sampling into December - during which month many of the giant kokopu whitebait were taken (140 of the 231 identified, or 66 % -Table 1).

The 1996-1998 sampling programme was relatively minor by comparison with the earlier work of McDowall & Eldon (1980). However, it confirmed the earlier conclusion that the whitebait of giant kokopu run late in the season, mostly beginning to enter West Coast rivers around the second week of November. This confirms the advice given to the Department of Conservation that closure of the fishery in early November would be an effective way to minimise the number of giant kokopu taken in the whitebait fishery. The results of the present sampling programme show that giant kokopu whitebait continue to enter rivers well beyond the termination of the existing fishing season (ending 14 November), and this affords the species an additional measure of escapement.

There is no conclusive, straightforward interpretation of the data on numbers of giant kokopu migrating. If the actual number of giant kokopu caught on a daily basis is accepted as the index of their occurrence, then maximum abundance seems to be in December. But there are no data on effort expended in catching the various samples, nor are there any data on the extent to which the sampling sites can be taken as representative of the river. Previous studies demonstrate that the catch composition and quantity vary greatly both within and between river systems, according to the characteristics of the river flows and the location of sampling sites, in relation to both distance upstream from the sea and proximity to inflowing tributary streams of varying characteristics (McDowall & Eldon 1980).

To some extent, conversion of the data, to percentages of each sample that giant kokopu contribute, compensates for variation in effort, but at the same time this conversion conceals day-to-day variations in the actual number of whitebait migrating. Thus the percentage of giant kokopu in the catch may be high only because there were few whitebait of other species migrating at that time, and low at some other time because there were many of the other species migrating. Certainly, by December, the general level of whitebait runs has declined very substantially, compared with runs during the core weeks of the whitebait fishing season, and this may have the effect of enhancing the relative abundance of giant kokopu.

For these reasons, at this stage of our knowledge, little more can be said than that:

1. giant kokopu whitebait mostly migrate into West Coast rivers from early November;

2. they continue to migrate into these rivers through much of December;

3. their numbers are probably always small, if measured as the actual number of fish migrating, though may be higher if measured as the proportion that giant kokopu contribute to the daily number of fish migrating at this time of the year;

4. the number migrating on any day varies very widely, though no more widely than the numbers of other species migrating;

5. factors that influence the timing and abundance of giant kokopu whitebait in the whitebait runs are totally unknown.

This sampling programme has revealed larger numbers of giant kokopu whitebait in the Buller and Hokitika Rivers than in the other rivers sampled. However, this reveals little, if anything, about the factors that control giant kokopu whitebait migrations. Earlier research (McDowall & Eldon 1980) has elucidated factors that control migrations of koaro and banded kokopu. Environmental variables such as water colour/pH, water temperature, and clarity seem implicated in explaining why different rivers, and different tributaries within river systems, have different ranges of species composition in their whitebait runs. There is insufficient information available from the present sampling programme to extend this understanding to giant kokopu. The major difference between the Buller and Hokitika Rivers, on one hand (with more numerous giant kokopu), and the "other" rivers sampled (Heaphy, Orowaiti, Okarito, and Mataura) has been the time range over which samples were taken. In most "other" rivers little sampling was undertaken during the period when the greatest numbers of giant kokopu whitebait were being taken in the Buller and Hokitika Rivers. This is, perhaps, emphasised by making the point that adult giant kokopu are known to be widespread in the upstream catchments of at least the Okarito and Mataura Rivers, although no giant kokopu whitebait were identified from the whitebait samples from these three rivers. Thus differences between rivers in catch composition probably reflect timing of sampling as much as or more than river characteristics.

4. Future research

The present study confirms earlier findings (McDowall & Eldon 1980) that giant kokopu whitebait tend to migrate later in the spring than other whitebait species such as inanga, koaro, and banded kokopu; the new data reported here extend the period of giant kokopu migration well into December. What drives this later migration is unknown. It could be different thresholds in

environmental cues that specifically trigger migrations by giant kokopu (such as water temperatures or photoperiod). Alternatively, timing could be driven in whole or in part by the fact that giant kokopu appear to spawn late in the autumn and early winter (McDowall 1990; McDowall & Kelly 1999), and that a determinate period of growth is necessary before the giant kokopu whitebait juveniles are adapted to returning to fresh water.

What controls populations of sub-adult to adult giant kokopu abundance in the lowland streams and wetlands, where this species is most often found, is also not understood. There is a perception that numbers of giant kokopu may have risen in recent decades, and this has been attributed to removal of large numbers of large predatory longfin eels, *Anguilla dieffenbachii* (family Anguillidae), from the same habitats. This is unconfirmed from abundance data and may be little more than conjecture but, if true, suggests that abundance of giant kokopu is unlikely to be controlled by juvenile recruitment under existing conditions of fishery-induced mortality. The Department of Conservation is presently funding a NIWA research programme on habitats important to conservation of giant kokopu populations and it is expected that this will clarify the species' habitat preferences. This information will, in turn, enable the Department to identify important areas of giant kokopu habitat. A critical question for giant kokopu conservation is then to determine whether these habitats are well-occupied by giant kokopu, or whether population densities are lower than might be predicted from habitat quality. If population densities are not as high as expected, this could be due to recruitment failure, which in turn may be a result of exploitation of giant kokopu whitebait in the fishery. Alternatively, more proximate factors like interspecific competition/predation involving eels or other predatory fishes such as the introduced brown trout, *Salmo trutta* (family Salmonidae), may be implicated.

In the first instance, ensuring that appropriate areas of suitable habitat are conserved is probably the most effective means of giant kokopu conservation. Present lack of any knowledge of spawning migrations and sites means that an area critical to the species' conservation remains unresolved. This would seem to be a key area for attention, particularly if giant kokopu undertake migrations to alternative habitats for spawning - conserving extensive areas of adult habitat becomes much more effective if there are adequate spawning grounds for the mature adults to exploit. Identification of spawning habitats therefore seems a priority.

These are all complex questions with no easily obtained answers.

5. Acknowledgements

This work was funded initially by a Department of Conservation research contract, though in the third year sampling was organised by DOC and samples sorted and data analysed by the author during the tenure of a James Cook Research Fellowship. Assistance of various whitebaiters in keeping samples is acknowledged, including Red Costley (Heaphy River), Alice Batt (Buller

River), Gary Jefferies, (Orowaiti River), Ralph Robinson, Ray Sadler, Ray Jollie, Ken Mehrtens, and Gordon Weaver (Hokitika River), Angela Anderson (Wanganui River), Mike Yates (Okarito River), and Tom Thomson (Mataura River). Associates of all of these individuals also played a role in the sampling programme. Assistance with organising the sampling programme was provided by Natasha Grainger and Philippe Gerbeaux, Department of Conservation,West Coast Conservancy.

6. Bibliography

McDowall, R.M. 1984. *The New Zealand whitebait book*. Reed, Wellington. 210 p.

McDowall, R.M. 1994. Changes in the West Coast whitebait fishing season, and seasonal distribution of the catch. *NIWA Consultancy Report* 12: 1-5

McDowall, R.M., Brothers, E.B. and Mitchell, C.P 1994. Age at migration from the sea of juvenile Galaxias in New Zealand (Pisces: Galaxiidae). *Bulletin of Marine Science* 54: 385-402.

McDowall, R.M. and Eldon, G.A. 1980. The ecology of whitebait migrations (Galaxiidae, *Galaxias* spp.*) New Zealand Ministry of Agriculture and Fisheries Fisheries Research Division, Fisheries Research Bulletin* 20: 1-171.

McDowall, R.M. and Kelly, G.R. 1999 Date and age at migration in juvenile giant kokopu, *Galaxias argenteus* (Gmelin) (Teleostei: Galaxiidae) and estimation of spawning season. *New Zealand Journal of Marine and Freshwater Research* 33: 263-270.

Northey, R. 1994. *Report of the Regulations Review Committee on a complaint relating to the Whitebait Fishing (West Coast) Regulations.* First Session, Forty-fourth Parliament, New Zealand House of Representatives, Wellington. 26 p.

Tisdall, C. 1994. *Setting priorities for the conservation of New Zealand's threatened plants and animals.* Department of Conservation, Wellington. 65 p.

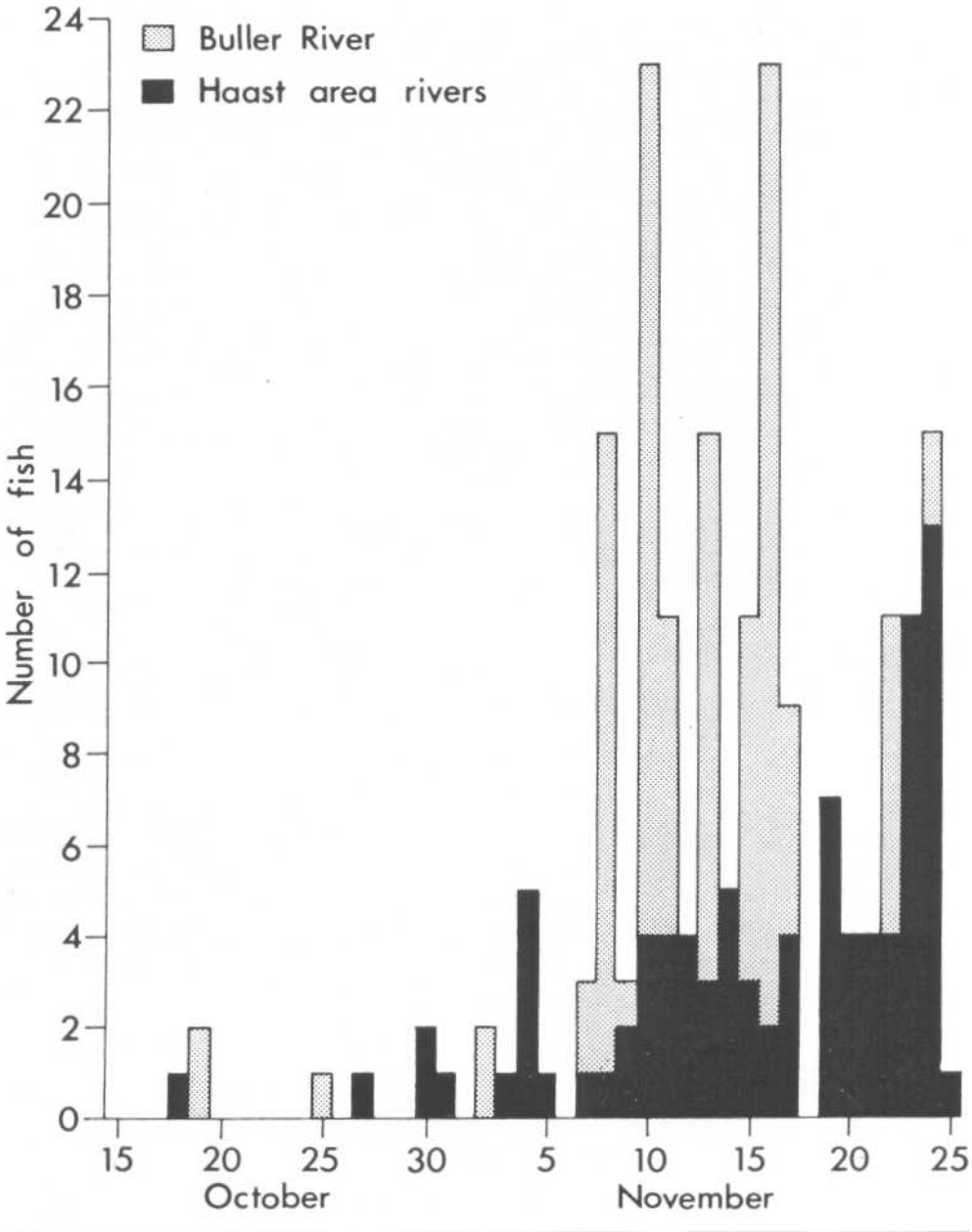

Figure 1. Seasonal distribution of captures of giant kokopu whitebait from a sampling programme in West Coast rivers from 1969 to 1973 (from McDowall & Eldon 1980)

Table 1. Composition of whitebait samples 1996-1998.

	1996								1997																1998								TOTAL			
	Buller				Hokitika				Heaphy				Orowaiti				Buller				Hokitika				Okarito				Buller				Hokitika							
Date	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*maculatus*	*brevipinnis*	*fasciatus*	***argenteus***	*MACULATUS*	*BREVIPINNIS*	*FASCIATUS*	***ARGENTEUS***
1-Nov																	40	3	1	0																			
2-Nov									274	28	53	0	298	0	12	0	21	1	1	0	5	4	0	0	203	0	6	0									40	3	1	0
3-Nov					91	108	5	0													12	1	5	0													801	33	72	0
4-Nov									240	33	38	0																									103	1	10	0
5-Nov													342	4	17	0	106	6	11	4																	240	33	38	0
6-Nov					64	67	75	0					255	23	10	1																					448	10	28	4
7-Nov																	53	1	1	1					81	0	3	0									400	23	88	1
8-Nov																																					53	1	1	1
9-Nov																																					0	0	0	0
10-Nov	62	103	44	0	62	103	4	0					56	0	5	0					76	4	5	0													132	4	10	0
11-Nov																					130	0	3	0													254	0	51	0
12-Nov																					153	0	9	0	99	0	0	0					13	22	3	23	265	22	12	23
13-Nov																					80	3	6	0													80	3	6	0
14-Nov					76	0	18	2					315	3	2	0					2	0	1	0													2	0	1	0
15-Nov					55	0	12	0													27	0	0	0	114	0	1	0									532	3	21	2
16-Nov																					150	5	1	0													205	5	13	0
17-Nov																					99	0	2	0													99	0	2	0
18-Nov																					112	4	2	0													112	4	2	0
19-Nov																					84	31	2	9													84	31	2	9
20-Nov																					77	10	10	3					100	15	8	0					177	25	18	3
21-Nov													238	1	3	1																					0	0	0	0
22-Nov																					86	1	7	2													324	2	10	3
23-Nov					112	0	35	0													68	4	5	1									55	1	0	0	123	5	5	1
24-Nov													339	1	11	2					141	3	7	3									34	0	0	1	287	3	42	4
25-Nov					88	0	16	0													18	0	4	4					3	4	0	2					360	5	15	8
26-Nov	31	2	2	2																	80	1	21	9	241	0	4	0					105	3	0	2	88	0	16	0
27-Nov	28	1	1	1									162	0	3	0	142	12	4	0																	457	4	27	13
28-Nov	54	1	2	13	89	0	15	1																													332	12	8	1
29-Nov																									175	0	22	0					103	7	0	1	143	0	17	14
30-Nov													124	0	2	0					110	0	28	3													278	7	22	1
1-Dec																																					234	0	30	3
2-Dec																																					0	0	0	0
3-Dec													64	1	3	0																					6	0	2	17
4-Dec																																					64	1	3	0
5-Dec																																					0	0	0	0
6-Dec													61	0	0	0	12	1	0	0													12	3	0	0	12	3	0	0
7-Dec					35	1	0	2																													73	1	0	0
8-Dec																	6	0	0	0																	35	0	0	2
9-Dec	45	0	2	0	43	0	3	4													0	1	2	3													6	0	0	0
10-Dec					16	2	1	0																													88	1	7	7
11-Dec	4	0	0	0													266	25	9	0	137	13	20	47									15	1	0	1	31	1	1	1
12-Dec													17	0	0	0					155	21	87	65													407	38	29	47
13-Dec																																					172	21	87	65
14-Dec	2	0	0	0																																	0	0	0	0
15-Dec																																					2	0	0	0
16-Dec																																					1	25	0	1
17-Dec																																					0	0	0	0
18-Dec																																					0	0	0	0
19-Dec																									8		16										8	0	16	0
20-Dec																																					0	0	0	0
21-Dec																																					0	0	0	0
22-Dec																																					0	0	0	0
23-Dec																																					0	0	0	0
24-Dec																																					0	0	0	0
25-Dec																																					11	1	0	0
26-Dec																																					0	0	0	0
27-Dec																																					0	0	0	0
28-Dec																																					0	0	0	0
29-Dec																																					0	0	0	0
30-Dec																																					0	0	0	0
31-Dec																																					0	0	0	0
	226	107	51	16	731	281	184	9	514	61	91	0	2271	33	68	4	646	49	27	5	1802	106	227	149	921	0	52	0	103	19	8	2	355	63	5	46	7569	331	713	231
																																					All samples			8844