



Identifying inanga spawning sites in plans: options for addressing post-quake spawning in Ōtautahi Christchurch

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10 February, 2016

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1. Introduction

The purpose of this assessment is to compare records of known inanga spawning sites in the waterways of Ōtautahi Christchurch from before and after the Canterbury earthquakes, with particular emphasis on information used in the design of planning methods for spawning site protection.

Environment Canterbury (ECan) has recently notified a list of known inanga spawning sites in Schedule 17 of the Plan Change 4 (ECan, 2015a) to the Canterbury Land and Water Regional Plan (ECan, 2015b). Ecan has also prepared maps of 'potential' inanga spawning sites for planning purposes (ECan, 2015b). Christchurch City Council (CCC) has developed maps of inanga spawning sites for consenting purposes, as extra mitigation is required by the Council when working in spawning areas (Margetts, 2016).). These maps consist of reaches of waterways that include locations at which eggs have been observed, as well as areas of suitable habitat immediately upstream and downstream of these eggs. The mapping process consisted of a desktop assessment of egg survey records, with the last update encompassing surveys from 2004-2011. Suitable habitat was assessed on a site-specific manner, based on a number of factors, including access for adult fish, aspect, soil conditions, bank slope and vegetation (B. Margetts, pers. comm.). The suitable habitat areas were included in the inanga spawning sites defined by CCC to address the difficulties in finding eggs in the field and the high potential for similar areas of suitable habitat immediately adjacent to observed eggs to also have had eggs in the past, or in the future. These sites informed, *inter alia*, the identification of Sites of Ecological Significance in the Proposed Christchurch Replacement District Plan (CCC, 2015).

Inanga spawning in the waterways of Ōtautahi Christchurch has been well documented since the late 1980s (Taylor et al., 1992). Following the Canterbury earthquakes, a change in the distribution of spawning sites has been identified based on extensive surveys conducted in 2015. The methodology used in these surveys is described in Orchard & Hickford (2016) together with detailed results. This information is particularly relevant to planning methods which seek to protect inanga spawning sites. It is therefore timely to consider the means by which spawning sites are defined in plans, and whether any changes are needed to include the new information.

2. Methods

To assess potential need to update spawning site information in plans, results from both pre- and post-quake surveys were compared to current planning provisions. Differences between the 2015 results and pre-quake records were first characterised by reviewing all known information on pre-quake spawning sites. The locations of these sites were mapped from the original data sources and compared to the post-quake data. Similarly, inanga spawning site information in plans was mapped and compared to the known sites.

A review of local literature and other data sources was completed with the assistance of Mark Taylor (Aquatic Ecology Ltd) to identify records of inanga spawning (Appendix 1). This included information held by local councils, the National Inanga Spawning Database (NISD), in published and grey literature, and in the local knowledge of inanga researchers.

Council records of inanga spawning sites were obtained from CCC and ECan. Data for the Ōtautahi Christchurch waterways was extracted from the National Inanga Spawning Database (NISD), mapped, and reviewed for consistency. Some discrepancies such as unlikely coordinate

locations were evident. To address these, an amended shapefile was prepared containing the estimated spawning locations for each record based on information in the 'Comments' field. As with the data provided by ECan, the NISD point data are general locations or 'centre-points' of spawning areas. They were mapped as point data and no attempt was made to estimate upstream and downstream limits from these records. CCC spawning site records consisted of upstream and downstream coordinates for reaches where eggs have been observed, and shapefiles used to create the CCC spawning area maps. The latter are lines extending the above reaches to include areas of suitable habitat upstream and downstream. For the other information sources, upstream and downstream limits for the areas of spawning were identified from the original records and all locations digitised in QGIS v2.8.2 (QGIS Development Team, 2015). Basemap imagery was sourced from LINZ.

Information held in reports was processed by identifying coordinates for upstream and downstream extents from maps or photographs provided in the original reports, or using original coordinates where possible. Where this information was not available, locations were estimated using the text descriptions provided. Reach lengths were then digitising based on the approximate shoreline position on the river bank to which each record related. Semi-continuous stretches of spawning were lumped into a single reach in some cases, generally following the description of discrete spawning areas and reaches given in the original records. Other details, such as the methodologies used for field surveys, can be found in the original reports (Appendix 1).

3. Results

A comparison of ECan, CCC, and NISD spawning site records reveals considerable differences (Figure 1). The most recent NISD records are dated 2004 and therefore more recent data are lacking. The original NISD records also contain some discrepancies likely related to data capture or transfer issues and the database as a whole generally retains these original entries (M. Hickford, pers. comm.). A rudimentary QA exercise was conducted, as above, to produce an amended set of spawning site locations more likely to be representative of the actual observations (orange stars in Figure 1).

Current records held by ECan are a mixture of extracts from original NISD records and more recent data from local researchers (M. Greer, pers. comm.). Discrepancies in the NISD records have been addressed within the ECan records and new coordinates assigned. Other ECan data points, such as at Lake Kate Sheppard and on Aynsley Terrace, relate to spawning locations found in a variety of other pre-earthquake studies for which data is not present in the NISD (blue triangles, Figure 1). In the Heathcote/Ōpāwaho these data points coincide well with the known pre-earthquake locations. However in the Avon/Ōtākaro there are many known spawning reaches that do not feature in the ECan spawning site records (orange lines in Figure 1b).

Current records held by CCC are spawning reaches that generally coincide well with the data available on pre-quake spawning areas. Details of these reaches include start and end point coordinates and text descriptions (Margetts, 2016). The descriptions indicate that both banks are generally included in the spawning reach identified. These CCC records do not include the site near Wilsons Road but this is much further upstream than other known sites and is thought to relate to a markedly different tidal regime associated with the opening of the Woolston Cut and before installation of the tidal barrage (M. Hickford, pers. comm.). A small discrepancy was

identified regarding the Woolston Park site as recorded by Taylor & Main (2010) which appears to be located a little further upstream than the CCC records indicate (Figure 1a).

Results from the post-quake surveys add considerably to this picture. In the Heathcote/Ōpāwaho, spawning was recorded further downstream on Clarendon Terrace and on both banks throughout this reach. However, no spawning was recorded above the Opawa Road site. New sites were found in the Radley Park area below the Woolston Cut. In the Avon/Ōtākaro, spawning was found in the mainstem upstream of all previous records, on both banks, and further downstream on the TLB. In Lake Kate Sheppard spawning was found within the previously recorded reach and concentrated within a particular area on the TLB.

Overall, this comparison of records highlights that there are several options for conceptualising and thus identifying spawning 'sites', or areas, for planning purposes. Decisions are needed on whether to identify locations on each bank separately, how to lump or split records into appropriate 'sites' or reach lengths, and how to recognise temporal aspects.

An overlay of all records by year illustrates some of the patterns to be addressed (Figure 2). In some places, notably the Opawa Road and Avondale Bridge sites, spawning has been consistently recorded in a similar area and the known spawning reach could be identified as the maximum bank length involved. In other situations decisions are needed on whether to 'connect' discrete spawning sites both spatially and temporally eg. to regard all of the interstitial areas as part of the 'site' or spawning reach. Examples include the records for the lower TRB of the Avon/Ōtākaro where sites near Orrick Crescent are well downstream of others, or on the TLB either side of Avondale Bridge where spawning has been recorded in some years but not others.

Whether to recognise each bank separately is another aspect for planning. The CCC approach is inclusive of both banks of the waterway within identified reaches. The ECan approach, based on points, clearly restricts attention to a relatively small area on a particular bank. Temporal aspects have generally been dealt with by including all previous records within the concept of 'known spawning sites'. The Wilson Road situation (described above) introduces an anomaly that has been treated differently by the councils though is unlikely to be a current spawning site.

The post-quake records may help resolve these considerations towards a common approach to recognising known spawning reaches. They show that spawning now occurs at a large number of locations in both catchments. Although there are a few extensive reaches where spawning was not recorded in 2015, many of these reaches supported spawning in the past with an example being the TLB of the Avon/Ōtākaro either side of Avondale Bridge. In combination these results suggest that it is appropriate to regard both banks as known spawning reaches over a considerable length of the mainstem in both rivers.

The new spawning sites in the lower Heathcote/Ōpāwaho present a remaining challenge in that there is currently no evidence for spawning in the 800m reach between Radley Street Bridge and Radley Park. More information on whether spawning does or could occur in this area is needed.

Figure 1. Comparison of inanga spawning records. (a) Heathcote/Ōpāwaho catchment.



(b) Avon/Ōtākaro catchment



Figure 2. Inanga spawning reaches by year.

(a) Heathcote/Ōpāwaho catchment. Detail in the boxed area is shown in Figure 2c.



(b) Avon/Ōtākaro catchment. Detail in the boxed area is shown in Figure 2c.



(c) Detailed view of sites near Opawa Road (top) and Avondale Road (bottom).



4. Discussion

This assessment highlights differences between the use of point data versus identifying spawning reaches as the means to include spawning site locations in plans. In a planning context, the effectiveness of either method can be related to the likelihood that spawning sites actually occur within the area of protection specified in plans. In the case of Plan Change 4 to the LWRP, point data for known locations are used and the area of protection is a 20m diameter circle centred on the point coordinates (ECan, 2015a). Unless there were many such points to include all known locations of spawning at this scale, a high proportion of known spawning areas would not be included.

For these reasons the spawning reach approach is considered to be more appropriate and practical for planning purposes. The concept of spawning reaches better addresses concerns raised by tangata whenua in consultation on Plan Change 4 (ECan, 2015b) which included the perspective that protecting known sites may not provide sufficient protection if limited to only a few known sites based on limited records. In this regard both approaches are prone to data deficiency and also currency issues, such as where survey and monitoring effort is not sufficiently high to detect significant shifts in the location of sites.

A potential shortcoming for identifying spawning reaches is reliance on having defensible information to indicate where the limits of known spawning are. This can be addressed by ensuring sufficient survey effort is targeted at this aspect. In the case of the Ōtautahi Christchurch waterways, there has been considerable survey effort made over many years from Mark Taylor, Mike Hickford and others, and this has generated a rich dataset on the actual locations used for spawning. It is practical and appropriate to capture this information as spawning reach data to assist waterways management.

The comparison between CCC's inanga spawning sites and the 2015 spawning survey results is also of interest (Appendix 2). Many of the new locations where eggs were recorded in 2015 occur in areas of 'suitable habitat' that are included in the CCC maps of inanga spawning areas (Margetts, 2016). In the case of the Avon/Ōtākaro mainstem the distribution of 2015 observations was a very close match to the reach mapped by CCC. However, in the Heathcote/Ōpāwaho mainstem the actual spawning sites distribution extends further downstream. No spawning was found in 2015 in the upstream portion of the reach mapped by CCC (ie. above Opawa Road), although spawning has occurred there before. In Lake Kate Sheppard the reach mapped by CCC extends much further upstream than the extent of spawning found in 2015. However a large proportion of the riparian habitat in this area is currently recovering from earthquake effects and vegetation communities have not yet stabilised. It is possible that spawning may occur further upstream in these waterways in the near future.

A different concept, that of 'potential' spawning areas, has been developed by ECan within its planning approach (ECan 2015b, Greer et al., 2015). It differs from the CCC 'suitable habitat' work in that it is largely based on a predictive desktop model rather than field surveys. It is potentially complementary though separate approach to the detection of known spawning sites. Such approaches are not the focus of this assessment, and the ECan 'potential spawning' areas are not further evaluated here.

5. Conclusions

This assessment provides updated information on inanga spawning reaches in Ōtautahi Christchurch and a comparison with existing records. Recent changes in the location of spawning reaches are considerable when compared to all previous records. These differences are highlighted and are important for planning and waterway management purposes. In the context of the Canterbury LWRP they are particularly relevant to planning methods specific to the locations of known inanga spawning sites. To support the implementation of these methods, it is recommended that council records are updated to reflect the findings presented here.

6. Acknowledgements

Assistance from Mark Taylor (Aquatic Ecology Ltd), Mike Hickford (University of Canterbury) and Shelley McMurtrie (EOS Ecology Ltd) is gratefully acknowledged and was invaluable for compiling inanga spawning reports and data. Assistance from council staff was also appreciated with particular thanks to Belinda Margetts (CCC), Duncan Gray (ECan) and Michael Greer (ECan). Support for the 2015 surveys and associated work was provided by the Ngāi Tahu Research Centre and IPENZ Rivers Group. Thanks also to the staff of the Waterways Centre for Freshwater Research, Marine Ecology Research Group and to the many volunteers who assisted with field research.

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Appendix 1. Original information sources⁺⁺

Year of survey	Information sources
1989	Eldon et al. (1989), Meurk (1989), Taylor et al. (1992)
1991	Taylor et al. (1992)
1993	Taylor (1996)
1994	Taylor (1994)
1995	Taylor (1995)
1996	Taylor (1996)
1997	Taylor (1997)
1998	Taylor (1998)
1999	Taylor (1999)
2000	Taylor (2000)
2002	University of Canterbury unpubl. data
2004	Taylor (2004)
2006	University of Canterbury unpubl. data
2007	Taylor & Chapman (2007)
2008	Hickford & Schiel (2014)
2010	Taylor & Main (2010) unpubl. data
2011	Taylor & Blair (2011)
2015	Orchard & Hickford (2016)

⁺⁺ Additional information was sourced the National Inanga Spawning Database (NISD) and communication with local researchers

Appendix 2. CCC inanga spawning reaches identified by field survey of suitable habitat upstream and downstream of locations where eggs were recorded (Margetts, 2016). The location of pre- and post-quake spawning sites is also shown. (a) Heathcote/Ōpāwaho catchment.



(b) Avon/Ōtākaro catchment.

