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Central and Arctic Region

Preliminary assessment of the suitability of Canadian Great Lakes tributaries for Asian carp spawning

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Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

Grass Carp (*Ctenopharyngodon idella*), Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), and Black Carp (*Mylopharyngodon piceus*), collectively known as Asian carps, are invasive species that have become established in the Mississippi River basin of North America and have had significant ecological and socio-economic impacts on its ecosystem. Previous risk assessments identified broad, potential risks to Canada and the United States, including the Great Lakes. These risk assessments included assessing the likelihood of establishment based on the availability of spawning and nursery habitats. Kocovsky et al. (2012) used more detailed data on thermal and hydrologic conditions to predict the suitability of eight tributaries in the western basin of Lake Erie for Asian carp spawning. The objective of this study is to refine the predictions of suitable spawning tributaries in the Canadian Great Lakes basin (bound downstream in the St. Lawrence River at 45°N) based on: unimpounded tributary length and a predictive decision-tree based on the reproductive biology of Asian carps and methods of Kocovsky et al. (2012).

Forty-three tributaries in the Canadian Great Lakes basin were identified as unimpounded from their mouth at the Great Lakes to at least 100 km upstream. Sixteen of these tributaries were in the Lake Superior basin, 14 in the Huron basin, five in the Erie basin, and eight in the Ontario basin. Based on the methods of Kocovsky et al. (2012), spawning conditions were determined to be suitable or highly suitable in 12 of 14 Erie tributaries with sufficient gauging data, 21 of 29 Huron tributaries, 18 of 40 Ontario tributaries, all four St. Lawrence tributaries in Ontario, and six of 12 Superior tributaries.

INTRODUCTION

Grass Carp (*Ctenopharyngodon idella*), Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), and Black Carp (*Mylopharyngodon piceus*), collectively known as Asian carps, are invasive species that have become established in the Mississippi River basin of North America and have had significant ecological and socio-economic impacts on its ecosystem (Chapman and Hoff 2011). These species were first introduced in the southern portion of the basin in the 1970s and have dispersed northward towards the Great Lakes basin (Kelly et al. 2011). The Great Lakes and Mississippi basins are hydrologically connected by the Chicago Sanitary and Shipping Canal (Moy et al. 2011). This connection has allowed the movement of fishes between the basins (e.g., Round Goby (*Neogobius melanostomus*) into the Mississippi (Laird and Page 1996, Koel et al. 2000, Chick and Pegg 2001)). Such movement is currently inhibited by the presence of electrical barriers in the canal (Moy et al. 2011); however, Asian carps might eventually circumvent the barriers in the event of barrier failure or by other human-mediated means such as movement and release through the bait and live food trades (Cudmore et al. 2012, 2017). Recently, increasing numbers and evidence of reproduction of Grass Carp have been reported in the Lake Erie basin (Chapman et al. 2013, Embke et al. 2016).

Risk assessments have identified broad, potential risks to Canada and the United States, including the Great Lakes (Mandrak and Cudmore 2004, Kolar et al. 2007, Cudmore et al. 2012, 2017). These risk assessments included assessing the likelihood of establishment based on the availability of spawning and nursery habitats. Asian carp spawning has been documented to occur in tributaries generally longer than 100 km (Krykhtin and Gorbach 1981, Kolar et al. 2007). Kolar et al. (2007) identified 22 American tributaries to lakes Erie, Huron, Michigan, and Superior that were unimpounded from the mouth to at least 100 km upstream. Mandrak and Cudmore (2004) took a more conservative approach, assuming that Asian carps may be able to spawn in shorter rivers, and identified 84 Canadian tributaries to the Great Lakes that were unimpounded from the mouth to at least 50 km upstream. Based on these results and the presence of suitable nursery habitats (wetlands), both risk assessments concluded that Asian carps could reproduce and establish in the Great Lakes if they were introduced.

The 100 km threshold for the minimum tributary length is related to the reproductive biology of Asian carps. It is believed that Silver Carp require an average of 2,685 total degree-days per year (GDD0; sum of mean daily water temperatures for all days above 0 °C) for each of several years to mature (Gorbach and Krykhtin 1981). In a northern native population, female Silver Carp matured at 4–10 years and males at 6–10 years (Gorbach and Krykhtin 1981). Once mature, they require a minimum water temperature of 17 °C and minimum number of total annual degree-days above 15 °C (GDD15) to reach spawning condition: 655 GDD15 for onset of spawning; and, 900 GDD15 for mass spawning (Gorbach and Krykhtin 1980). Asian carps are only known to spawn in rivers and it is believed that a rising hydrograph (flood event) is a primary spawning cue (Kolar et al. 2007). Spawning commonly occurs where there is a mixing of water, such as the confluence of rivers, rapids, or behind sandbars or islands (Kolar et al. 2007). Once the eggs are released and fertilized, it is thought that the semi-buoyant, fertilized eggs need to remain suspended in current until they hatch (Kolar et al. 2007). As fertilized eggs are approximately neutrally buoyant, they require a flow of about 0.1 m/s to remain suspended (Gorbach and Krykhtin 1980). Hatching time is related to temperature (Kolar et al. 2007 and references therein). It is thought that the newly hatched larvae need to settle in productive habitats (e.g., wetlands) for feeding and/or protection (Kolar et al. 2007). A recent spawning model has concluded that Grass Carp may be able to spawn in substantially shorter rivers depending on the amount of turbulence and dead zones in the river (Heer et al. 2020a,b).

Kocovsky et al. (2012) used thermal and hydrologic conditions to predict the suitability of eight tributaries in the western Lake Erie basin for Asian carp spawning. They used length of undammed river, predicted summer temperatures, and predicted water velocity during flood events to determine whether sufficient lengths of river are available for spawning of Asian carps. Most rivers examined were unimpounded for at least 100 km from the mouth and had summer temperatures suitable (> 21 °C) for rapid incubation of eggs of Asian carps. Predicted water velocity and temperature were sufficient to ensure that incubating eggs, drifting in the water column, would hatch before reaching Lake Erie for most flood events in most of the rivers if spawned far enough upstream. The Maumee, Sandusky, and Grand rivers were predicted to be the most likely to support Asian carp spawning, and the Black, Huron, Portage, and Vermilion rivers were predicted to be less suitable. The model of Kocovsky et al. (2012) assumed simple linear velocity of eggs; however, the continued suspension and flow of eggs will be influenced by turbulence. To account for turbulence, Garcia et al. (2013) developed a three-dimensional model of the egg position in the water column over time. This model requires Acoustic Doppler Current Profiler surveys or a hydrodynamic model, both of which require considerable resources and data (Murphy and Jackson, 2013, Garcia et al. 2015). However, to date, such data or models are generally not available for tributaries in the Canadian Great Lakes basin (but see Heer et al. 2019). Heer et al. (2019) used daily flow and temperature data obtained from the Toronto Region Conservation Authority in a model similar to the Kocovsky et al. (2012) to determine the suitability of eight Toronto-area Lake Ontario tributaries for Asian carp spawning. Inter-annual suitability varied greatly, and six tributaries were found to be suitable in at least one of six years over the study period, 2009–2014.

The objective of this study is to refine the predictions of suitable spawning tributaries across the Canadian Great Lakes basin (bound downstream in the St. Lawrence River at 45°N) based on unimpounded tributary length (sensu Mandrak and Cudmore 2004, Kolar et al. 2007), and by developing a predictive decision-tree based on the reproductive biology of Asian carps, data available for tributaries in the Canadian Great Lakes basin, and methods of Kocovsky et al. (2012).

METHODS

For the Canadian Great Lakes basin, tributaries suitable for Asian carp spawning were identified by using only unimpounded tributary length and by predicting suitability based on reproductive requirements similar to Kocovsky et al. (2012).

In the event that 50 km, as used in Mandrak and Cudmore (2004), is too short for successful spawning, tributaries unimpounded from their mouth at a Great Lake to at least 100 km upstream were identified as done in Kolar et al. (2007). Unimpounded stream length was measured using Network Analyst in ArcMap 9.3. A network was developed using the 1:10,000 Waterflow layer compiled by the Ontario Ministry of Natural Resources and Forestry (OMNRF). A barrier layer was constructed using data from OMNRF (Dams and Barriers, Water Structures, DrainagePoint (Falls object only), DrainagePoint (Falls object only) layers), and Natural Resources Canada CanVec (BlockedPassage, HydrographicObstacle (Falls object only), ManmadeHydrographicEntity). Unimpounded stream length was measured from a point created at the intersection of each tributary and the Great Lakes shoreline to 100 km, or the first barrier, whatever came first.

Tributaries suitable for Asian carp spawning were also identified based on their reproductive requirements related to water temperature and velocity (sensu Kocovsky et al. 2012). The Water Survey of Canada (WSC) has online data reporting mean discharge and, sometimes, temperature, but does not report velocity, which is a key driver of Asian carp spawning, or provide discharge ratings curve that can be used to back-calculate velocity from discharge. Therefore, manually measured velocity and temperature data used to develop discharge ratings curves at their gauging stations were obtained from WSC for 865 stations in the Canadian Great Lakes basin including the St. Lawrence River to the Quebec border (Figure 1). The data were generally measured on multiple dates per year over multiple years, 1960–2010, but were not sufficient to calculate mean daily or weekly values. Therefore, mean, maximum, and minimum values for temperature and velocity were calculated on a biweekly basis and plotted for each of 865 stations with at least five years of data (Figure 1, Figure 2). A line parallel to the x-axis was added to the plot to represent velocity of 0.7 m/s (Figure 2), commonly reported in the literature as a threshold velocity required to trigger spawning (Kocovsky et al. 2012), although simply a rising hydrograph may be sufficient (Verigin 1979, Yi et al. 1988, Embke et al. 2016). The temperature data were also used to determine if GDD0 of 2,685 total degree-days per year, required over several years for maturity, was reached at each gauging station. Trend surfaces for GDD0 were interpolated using inverse weighted distance from the Water Survey of Canada gauging station data to determine the general patterns of these variables in the Canadian Great Lakes basin. As the Asian carps may actually mature in the Great Lakes proper prior to undertaking spawning migrations into tributaries, GDD0 was also obtained for the Great Lakes from the National Oceanic and Atmospheric Administration (NOAA) Great Lakes Coastal Forecasting System.

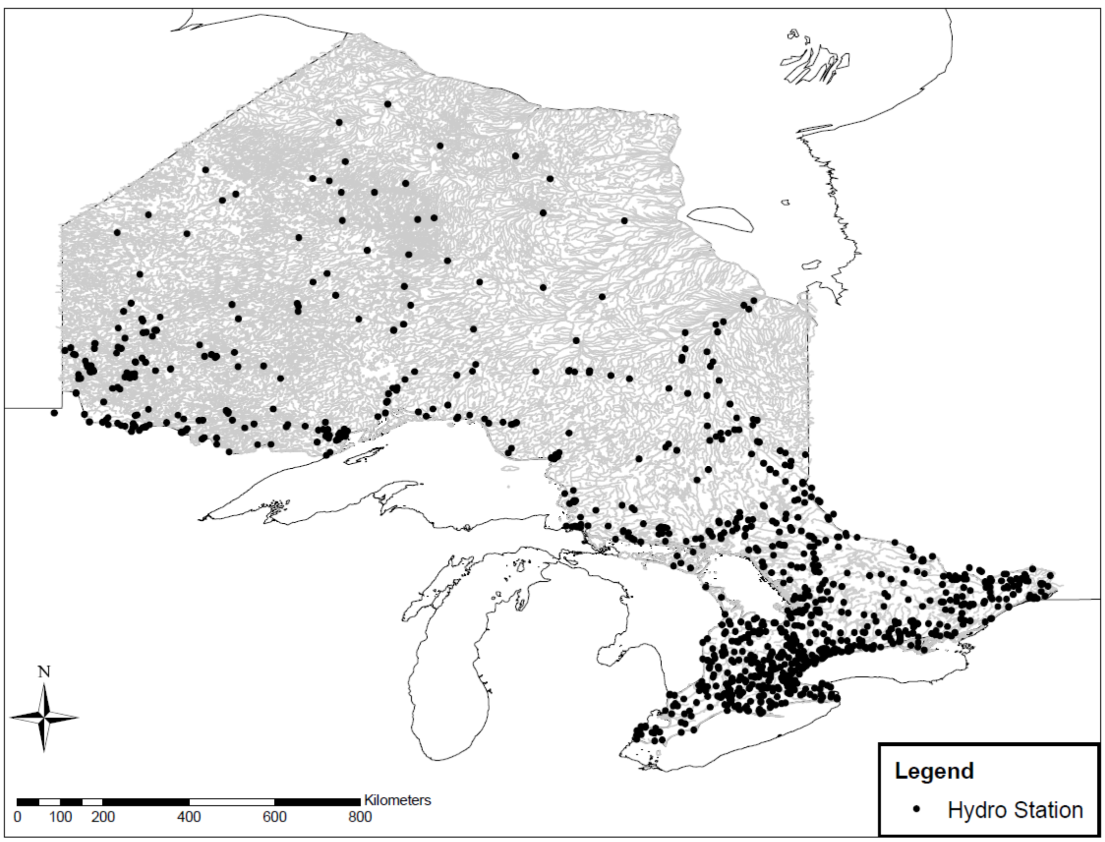
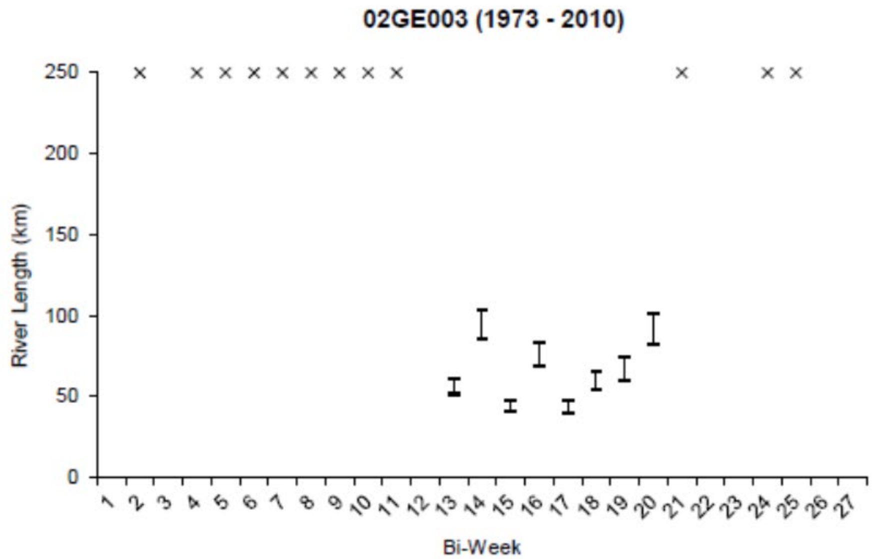


Figure 1. The 865 Water Survey of Canada stream gauging stations considered in this survey.



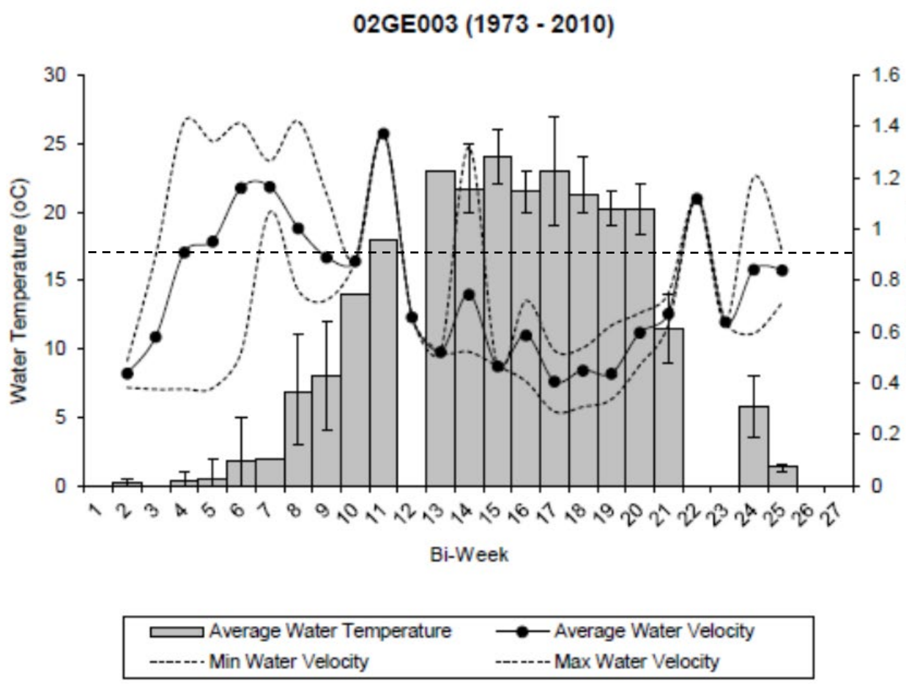


Figure 2. An example of the graphs used to assess suitability of tributaries in the Great Lakes basin for Asian carp spawning on a biweekly basis. In this example, "02GE003" is the gauging station number and "(1973–2010)" is the range of years for which data are available. Note that this analysis was done only for stations with a minimum of five years of records. Top graph: The bars represent the range of river length required based on Equation 1, which is based on water velocity and water temperature requirements for egg drift and hatch. The horizontal lines on the bar represent, from top to bottom, the results based on: average values using the equation of Anonymous (1970); average values using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (min-max) continuous lines. The horizontal dashed line represents a water velocity of 0.7 m/s, often identified as minimum flow required to trigger spawning.

Calculations of 655 and 900 GDD15, required for onset and mass spawning at maturity, based on the biweekly water temperatures at the gauging stations indicated that these values would generally not be attained in the rivers (data obtained from the Great Lakes Aquatic Habitat Framework). However, these temperatures would not be representative of all, potentially warmer, microhabitats in the river or areas at the mouth and in the lake adjacent to the spawning river.

Length (km) of river required for egg hatching (D) was calculated and plotted (Figure 2) on a biweekly basis based on hatching time and stream velocity using the following equation (after Kocovsky et al. 2012):

$$\mathrm{D} = 3600 * \mathrm{V} * 1/1000 = 3.6 * \mathrm{V} * \mathrm{I} \qquad \text{(Equation 1)}$$

where V = stream velocity (m/s), I = estimated incubation time (h), 3600 = s/h, and 1,000 = m/km.

Estimated incubation times for Asian carps have been published by several authors. Nico et al. (2005) provided two equations for egg hatching times in Asian carps from the Chinese literature: Black Carp (Chang 1966); and, Grass Carp (Anonymous 1970 as cited in Nico et al. 2005) (Table 1). Egg hatching times are also provided for Silver Carp by Guo (1980) and Tsuchiya (1980, as cited in Kolar et al. 2007). Power equations based on the four studies are not significantly different (ANOVA, $F = 0.38$, $p = 0.77$); therefore, we used the equations that gave the lowest and highest mean hatching times over the 15–35°C temperature range – Anonymous (1970; as cited in Nico et al. 2005) and Chang (1966), respectively. Using these two equations, length of river required for hatching was calculated on a biweekly basis using average velocity and temperature to determine average river length required and maximum velocity and temperature to determine minimum river length required (Figure 2).

Table 1. Hatching rates for Asian carp eggs. y = hatching time (h); x = water temperature (°C). The equations are not significantly different (ANOVA; F = 0.38, p = 0.77).

Species	Equation	R^2	Reference
C. idella	$y = 233855x^{-2.4915}$	0.9902	Anonymous 1970 (cited in Nico et al. 2005)
	$y = 18779x^{-1.979}$	0.9736	Guo 1980
H. molitrix	$y = 22456x^{-2.0989}$	0.988	Guo 1980
	$y = 21311x^{-2.8057}$	0.9539	Tsuchiya 1980 (cited in Kolar et al. 2007)
M. piceus	$y =2\ 33855x^{-2.822}$	0.9736	Chang 1966

A decision tree was developed based on the spawning requirements of Asian carps related to water temperature (used to measure growing degree-days and calculate hatching rate) and velocity (used to identify rising hydrographs and calculate minimum unimpounded river length) (Figure 3). As wetlands are present throughout the basin and in most tributary mouths (Mandrak and Cudmore 2004), nursery habitat is likely present in the lower reaches of most tributaries; therefore, nursery habitat was not included in the final decision tree.

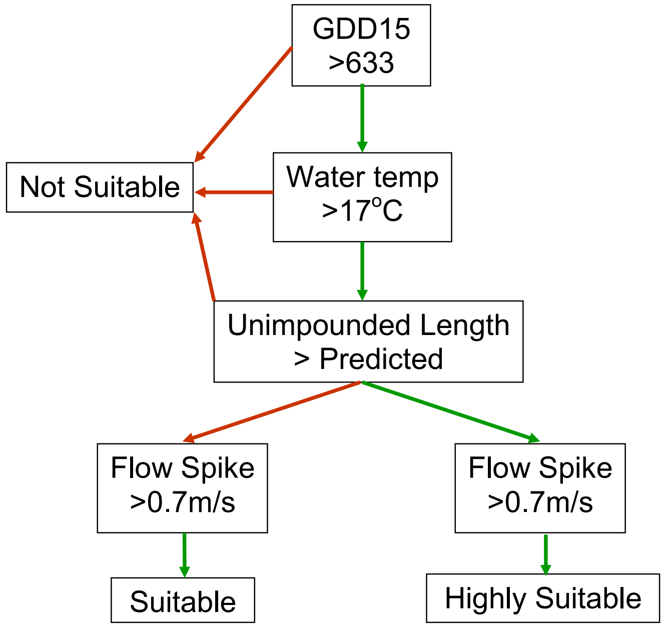


Figure 3. Decision tree used to assess suitability of tributaries in the Canadian Great Lakes basin for Asian carp spawning.

The decision tree (Figure 3) was applied to the figures for each gauging station with sufficient temperature and velocity data and the following information was recorded (Appendix 2):

i. unimpounded length using the method described above or using Google Earth where barriers were known but not in GIS barrier layer;

ii. biweek by which water temperature > 17 °C;

iii. minimum length of stream required by biweek when water temperature > 17 °C;

iv. shortest of the minimum length of stream required;

v. biweeks of flow spikes;

vi. biweeks of possible spawning;

vii. biweeks of possible spawning with flow spikes > 0.7 m/s;

viii. final spawning suitability; and,

ix. comments on reason why deemed not suitable.

As many tributaries had several gauging stations, overall suitability for each tributary was determined to be the maximum suitability among the gauging stations found in the tributary.

RESULTS AND DISCUSSION

PREDICTIONS BASED ON UNIMPOUNDED RIVER LENGTH

Forty-three tributaries in the Canadian Great Lakes basin were identified as unimpounded from their mouth at the Great Lakes to at least 100 km upstream (Figure 4). Sixteen of these tributaries were in the Lake Superior basin, 14 in the Huron basin, five in the Erie basin, and seven in the Ontario basin. These counts are based on the intersections of tributaries and the coastline (i.e. the mouths) in Figure 4. These tributaries are less than half of the 84 tributaries unimpounded for 50 km identified by Mandrak and Cudmore (2004).

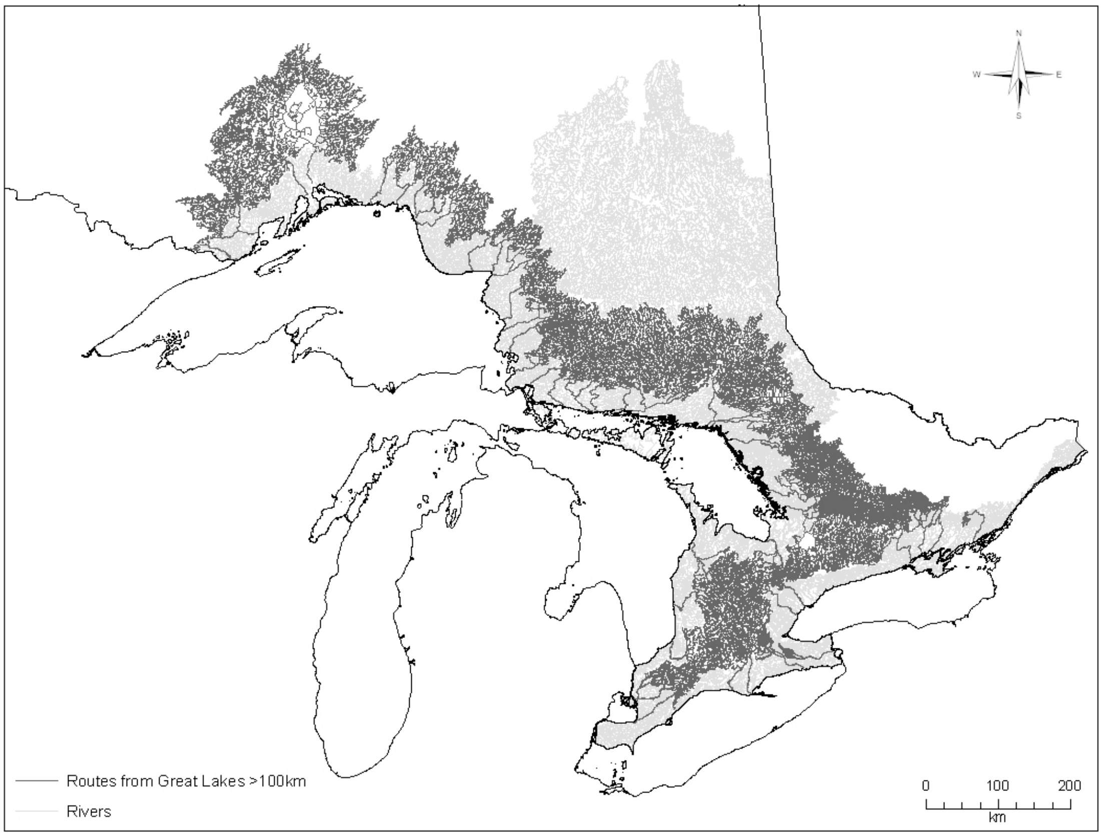


Figure 4. Tributaries in the Canadian Great Lakes basin unimpounded from the mouth at a Great Lake to at least 100 km upstream (represented by dark grey lines).Combined light grey and dark grey lines represent all major tributaries in the Canadian Great Lakes basin at a scale of 1:10 000.

PREDICTIONS BASED ON SPAWNING SUITABILITY DECISION TREE

GDD0 reaches 2,655 for the gauging stations in the Erie, Huron, and Ontario basins, but only one of 12 otherwise suitable stations in the Superior basin. When interpolated from the gauging station data, GDD0 exceeds 2,600 in all basins but Superior (Figure 5). GDD0 exceeds 2,865 in most of lakes Erie, Huron, and Ontario, and large parts of Lake Superior (Figure 6). This indicates that Asian carps could mature to spawning condition in either the tributaries or lake proper of lakes Erie, Ontario, and Huron. Asian carps could mature in large parts of Lake Superior proper but not in most of its tributaries.

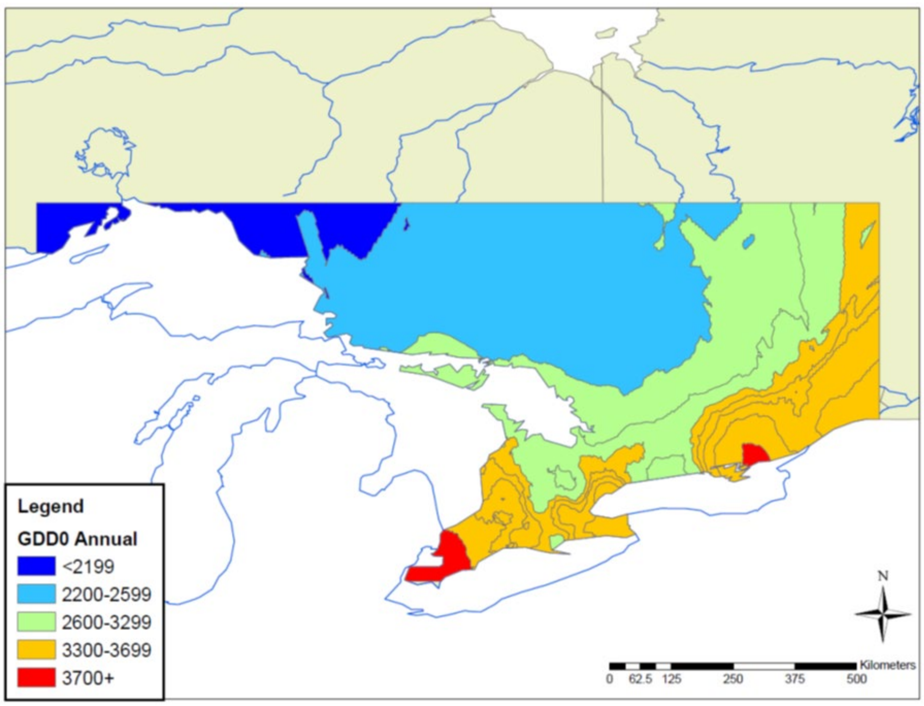


Figure 5. Annual cumulative growing degree-days above 0 °C based on data for Water Survey of Canada gauging stations. An average of greater than 2,685 is required over several years for Asian carp maturation.

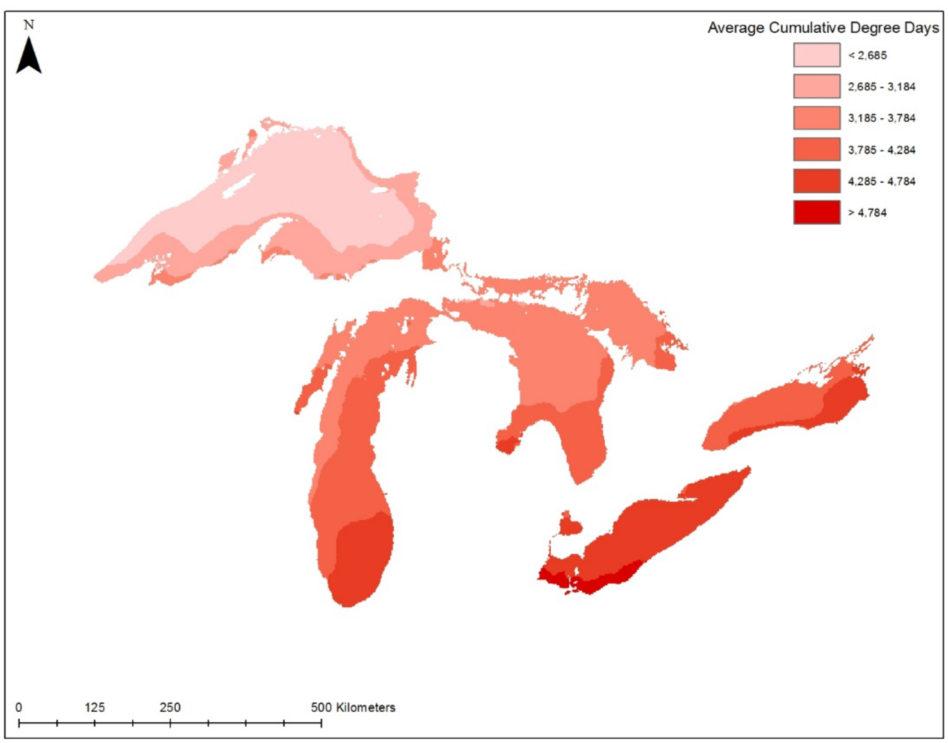


Figure 6. Mean annual cumulative growing degree-days above 0 °C based on Great Lakes mean daily surface temperatures, 1995–2013. Data obtained from [the Great Lakes Aquatic Habitat Framework](). An average of greater than 2,685 is required over several years for Asian carp maturation.

Of the 572 gauging stations with sufficient data to produce suitability graphs, there was sufficient data on the graphs to determine suitability at 222 stations in 99 tributaries (Appendix 2). Spawning conditions in the Canadian Great Lakes basin were determined to be suitable or highly suitable in 12 of 14 Erie tributaries with sufficient gauging data, 21 of 29 Huron tributaries, 18 of 40 Ontario tributaries, all four St. Lawrence tributaries, and six of 12 Superior tributaries (Tables 2, 3; Figures 7, 8). Tributaries that lacked suitable spawning conditions in Lake Huron and Lake Ontario tributaries largely were typically too short (Table 4), which is not surprising given the number of anthropogenic barriers in these basins. Lake Erie tributaries lacking suitable spawning conditions were either too short or exhibited no flow spike to trigger spawning as many Canadian Lake Erie watersheds are short in length and small in area. Some Lake Superior tributaries were not suitable due to barriers, typically dams, or lack or lateness of flow spikes that may be the result of headwater damming.

Table 2. Tributaries in the Canadian Great Lakes basin ((a) Erie, (b) Huron, (c) Ontario, (d) St Lawrence, (e) Superior) suitable for Asian carp spawning based on application of decision tree (see Figures 7 and 8, and Appendix 2) to data for 220 stream gauging stations. See Figure 8 for map of tributary locations. Suitability: 0 – not suitable; 1 – suitable; 2 – highly suitable.

a) Erie

	No. of Stations			
	Suitability			Maximum Suitability
Tributary	**0**	**1**	**2**	
Big Creek	0	4	0	1
Big Otter Creek	2	4	0	1
Canard River	0	0	1	2
Catfish Creek	0	2	0	1
Grand River	1	2	7	2
Kettle Creek	0	2	1	2
Little River	0	1	0	1
Lynn River	1	0	0	0
Nanticoke Creek	0	0	1	2
Ruscom River	0	1	0	1
Sturgeon Creek	0	1	0	1
Sydenham River	1	1	1	2
Thames River	1	7	5	2
Turkey Creek	1	0	0	0

b) Huron

	No. of Stations			
	Suitability			Maximum Suitability
Tributary	**0**	**1**	**2**	
Ausable River	0	2	2	2
Bayfield River	0	1	2	2
Beaver River	1	0	0	0
Bighead River	0	1	0	1
Copeland Creek	0	1	0	1
Cow Creek	0	1	0	1
French River	0	2	3	2
Garden River	0	1	0	1
Hog Creek	0	1	0	1
Lucknow River	1	0	0	0
Magnetawan River	3	1	0	1
Maitland River	1	5	5	2
Mississagi River	1	0	0	0
Moon River	1	0	0	0
North River	1	1	0	1
Nottawasaga River	0	5	0	1
Penetangore River	0	1	0	1
Pine River	0	0	1	2
Pretty River	0	1	0	1
Sauble River	0	1	1	2
Saugeen River	8	0	0	0
Serpent River	0	4	1	2
Severn River	6	0	0	0
Spanish River	0	1	0	1
Stokes River	0	1	0	1
Sturgeon River	0	1	0	1
Sydenham River	1	0	0	0
Wanapitei River	0	2	0	1
Wye River	1	0	0	0

c) Ontario

	No. of Stations			
	Suitability			Maximum Suitability
Tributary	**0**	**1**	**2**	
Ancaster Creek	1	0	0	0
Black Creek	1	0	0	0
Bloomfield Creek	0	1	0	1
Bowmanville Creek	0	1	0	1
Bronte Creek	1	1	0	1
Cobourg Brook	1	0	0	0
Collins Creek	0	1	0	1
Credit River	2	5	2	2
Don River	3	0	0	0
Duffins Creek	2	2	1	2
Etobicoke Creek	0	1	1	2
Farewell Creek	1	0	0	0
Four Mile River	1	0	0	0
Fourteen Mile Creek	1	0	0	0
Ganaraska River	0	2	1	2
Grindstone Creek	2	0	0	0
Harmony Creek	1	0	0	0
Highland Creek	0	1	0	1
Humber River	6	0	0	0
Little Cataraqui Creek	1	0	0	0
Mayhew Creek	1	0	0	0
Millhaven Creek	1	1	0	1
Mimico Creek	0	1	0	1
Moira River	2	0	0	0
Napanee River	1	0	0	0
Oshawa Creek	1	0	0	0
Oswego Creek	0	1	0	1
Redhill Creek	2	0	0	0
Rouge River	0	1	2	2
Salmon River	2	0	0	0
Shelter Valley Creek	1	0	0	0
Sixteen Mile Creek	0	0	2	2
Spencer Creek	2	0	0	0
Stoney Creek	1	0	0	0
Trent River	0	1	1	2
Twenty Mile Creek	1	0	0	0
Welland River	0	1	0	1
West Duffins Creek	0	1	0	1
Wilmot Creek	1	0	0	0
Wilton Creek	0	1	0	1

d) St Lawrence

	No. of Stations			
	Suitability			Maximum Suitability
Tributary	**0**	**1**	**2**	
Butlers Creek	0	1	0	1
Raisin River	0	1	0	1
Riviere Beaudette	0	0	1	2
Riviere Delisle	0	2	0	1

e) Superior

	No. of Stations			
	Suitability			Maximum Suitability
Tributary	**0**	**1**	**2**	
Batchawana River	6	0	0	0
Big Carp River	1	0	0	0
Current River	2	0	0	0
Dog River	1	0	0	0
Goulais River	1	0	0	0
Gravel River	0	1	0	1
Little Pic River	0	0	1	2
McIntyre River	2	1	0	1
Mission River	2	0	0	0
Pic River	1	1	0	1
Pukaskwa River	0	1	0	1
Steel River	0	1	0	1

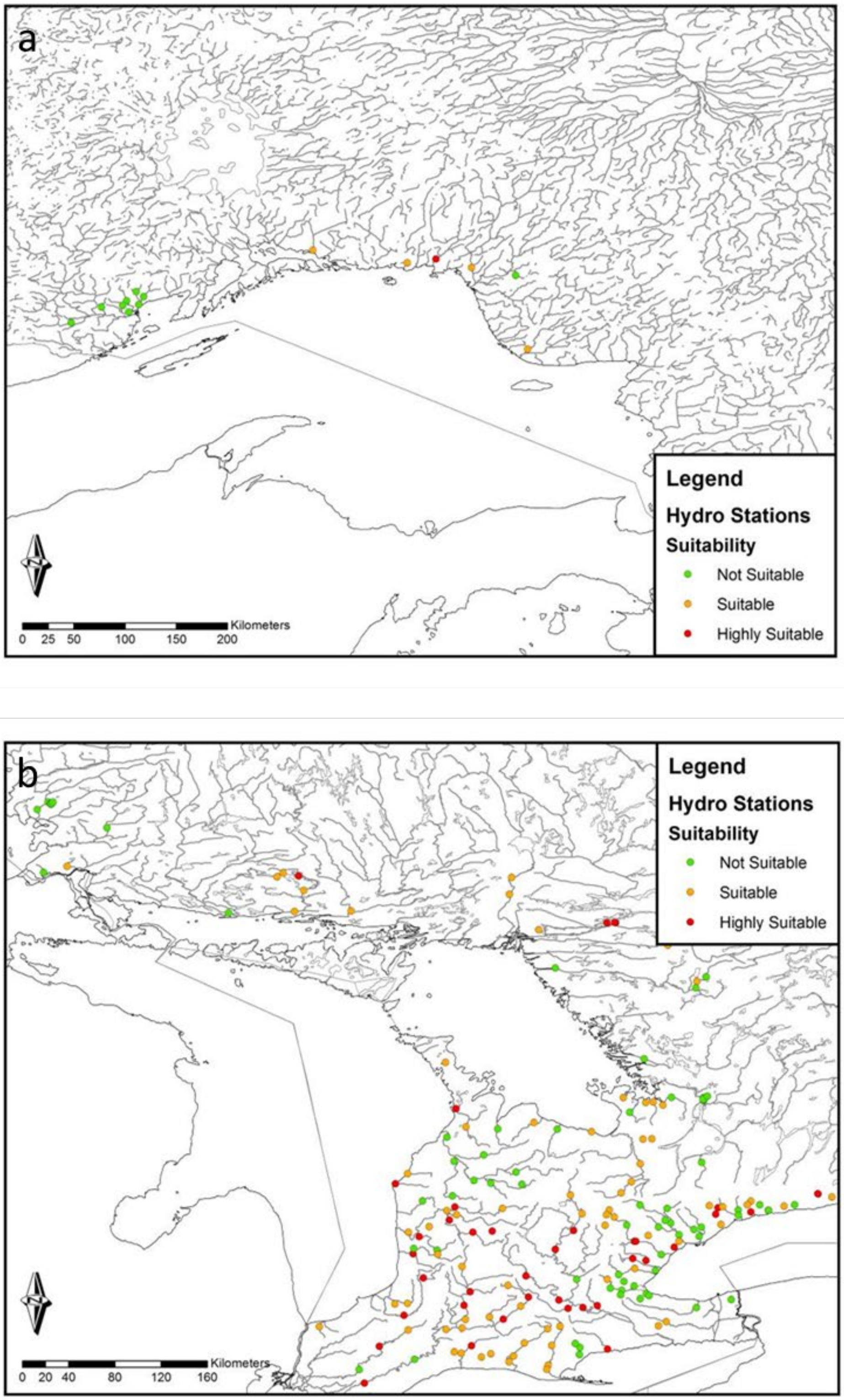
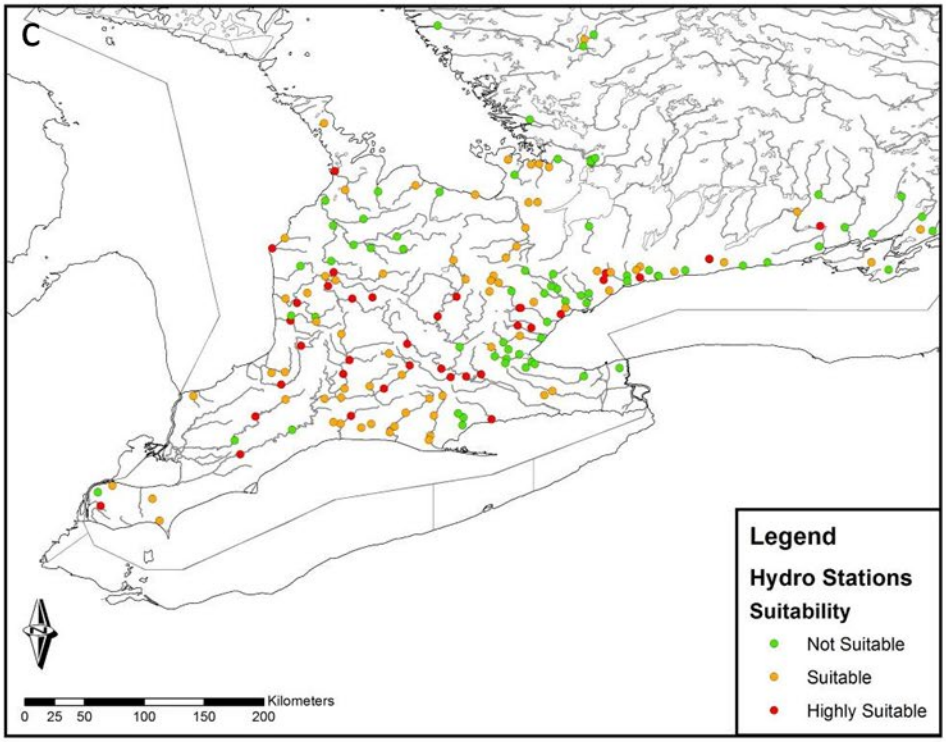
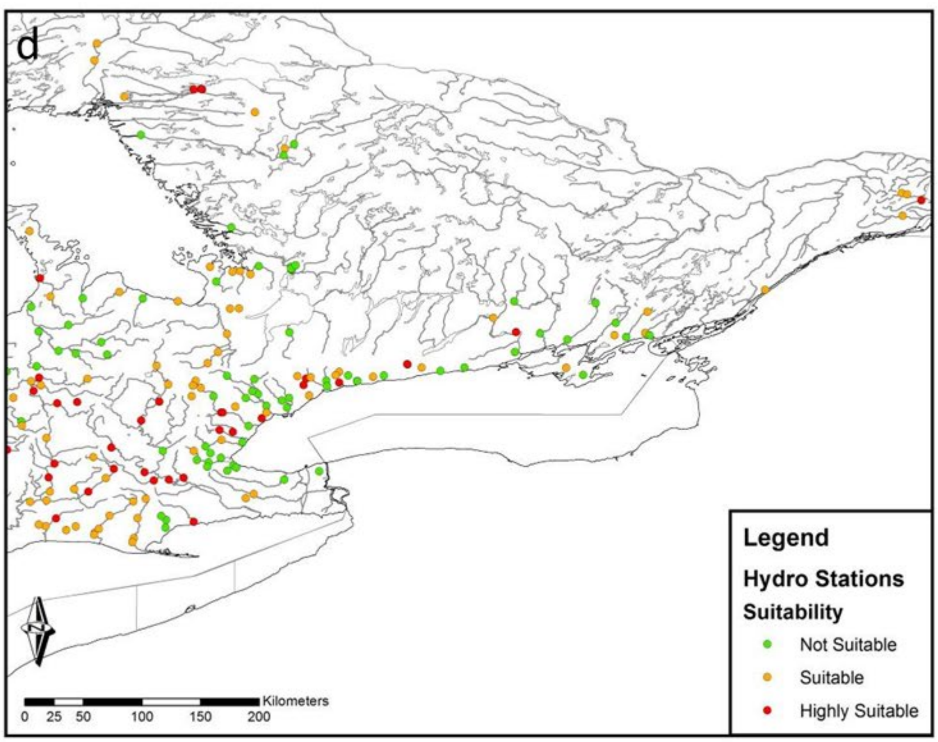


Figure 7. Suitability of tributaries for Asian carp spawning at 222 stream gauging stations in the Canadian Great Lakes basin: a) Superior; b) Huron; c) Erie; d) Ontario.





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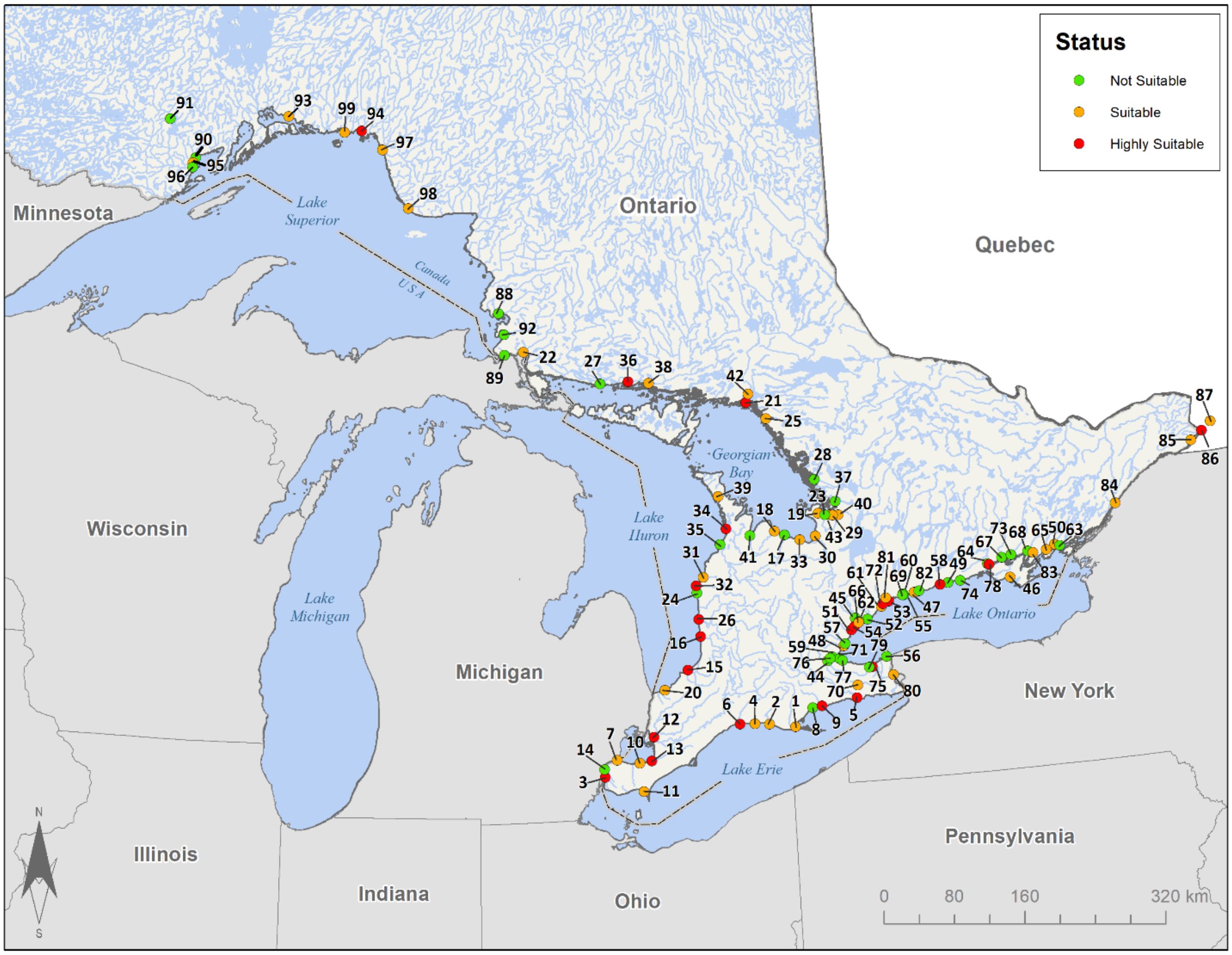

Figure 8. Mouth coordinates of tributaries in the Canadian Great Lakes basin suitable for Asian carp spawning. Suitability: 0 – not suitable; 1 – suitable; 2 – highly suitable. Tributary names are found in Appendix 3.

Table 3. Summary of tributaries in the Canadian Great Lakes basin suitable for Asian carp spawning based on Table 2. Suitability: 0 – not suitable; 1 – suitable; 2 – highly suitable.

Basin	No. of Tributaries	Suitability		
		0	1	2
Erie	14	2	6	6
Huron	29	8	14	7
Ontario	40	22	12	6
St. Lawrence	4	0	3	1
Superior	12	6	5	1

Table 4. Reasons why tributaries in Canadian Great Lakes basin are not suitable for Asian carp spawning by basin based on Appendix 2.

Basin	No. of Stations		
	Tributary Too Short	No Flow Spike	Flow Spike Too Late
Erie	4	3	0
Huron	22	4	0
Ontario	40	1	0
Superior	3	7	1

Although the 100 km analysis included all tributaries in Ontario, the more detailed analysis indicated that much less than 100 km of stream length was required when temperature and flow conditions were optimal, as also found by Heer et al. (2019, 2020a,b). Suitable spawning streams were as short as 10.4 km and highly suitable spawning streams were as short as 30.2 km. The models used in this report and in Kocovsky et al. (2012) rely on linear velocity measurements at few locations and are, thus, coarse drift models. They did not consider shear velocity, lateral velocity, turbulence diffusion, and water density related to temperature, which may influence egg settling velocities and travel times and, hence, distance to hatch (Garcia et al. 2015). Murphy and Jackson (2013) incorporated shear velocity into a model of Asian carp spawning suitability and concluded that all four of the tributaries assessed (two in Lake Michigan: the Milwaukee and St. Joseph rivers and two in Lake Erie: the Maumee and Sandusky rivers) are suitable for bigheaded carp spawning and that river reaches as short as 25 km may allow bigheaded carp eggs sufficient time to develop to hatching. Garcia et al. (2013) developed a fluvial egg drift model of Silver Carp spawning suitability that incorporated flow velocity, shear dispersion, and turbulent diffusion. The model was evaluated using experimental data from China and applied to data for the Sandusky River and indicated that the river would be suitable for Silver Carp spawning. Heer et al. (2020b) concluded that the Sandusky River was suitable for Grass Carp spawning using a complex 3-D hydrodynamic model, validated by actual hydrodynamic and spawning data, to account for shear velocity, lateral velocity, turbulence diffusion, and dead zones. All models for the Sandusky River concluded that it is suitable for Asian carp spawning, which is consistent with the conclusion that Grass Carp have successfully spawned and recruited in the Sandusky River (Chapman et al. 2013, Embke et al. 2016). Heer et al. (2020a) applied their 3-D hydrodynamic model to the Don River and concluded that Asian carp eggs could develop successfully if spawned at least 25 km upstream and that close to 100% hatching success would be achieved if spawned 40 km upstream.

As temperature and flow data were sufficient to assess only a subset of the tributaries in the Canadian Great Lakes, the spawning suitability of many tributaries remains unknown. More detailed temperature and flow data may be available at more local levels (e.g. conservation authorities) and should be used to examine suitability and finer spatial and temporal, including inter-annual variation, scales (e.g. Heer et al. 2019).

Each tributary identified in this study as being suitable for Asian carp spawning should be examined more closely to confirm that no barriers exist between the mouth and the shortest distance required for spawning as identified in the Appendix 2. Potential spawning sites should also be identified. Predictions for these tributaries could be further refined by modeling with more detailed data on flow velocity, shear dispersion, and turbulent diffusion, as done by Garcia et al. (2013), Murphy and Jackson (2013), and Heer et al. (2020a,b).

Spawning is unlikely dependent upon temperature and flow alone, but also dependent on habitat variables such as minimum stream width and other factors. As our understanding of Asian carp spawning increases with increasing North American research (e.g., Chapman and Hoff 2011) and additional data become available, models predicting spawning success should be refined for the tributaries identified in this study and for the others for which data are currently lacking.

In summary, 41 tributaries in the Canadian Great Lakes basin were identified as unimpounded from their mouth at the Great Lakes to at least 100 km upstream. Sixteen of these tributaries were in the Lake Superior basin, 14 in the Huron basin, five in the Erie basin, and eight in the Ontario basin. Based on the methods of Kocovsky et al. (2012), spawning conditions were determined to be suitable or highly suitable in 12 of 14 Erie tributaries with sufficient gauging data, 21 of 29 Huron tributaries, 18 of 40 Ontario tributaries, all four St. Lawrence tributaries in Ontario, and six of 12 Superior tributaries.

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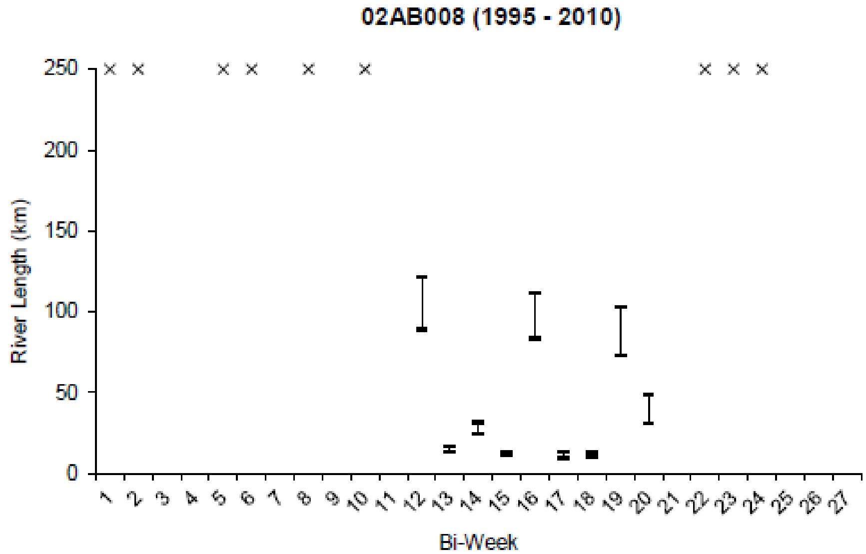
APPENDIX 1. TRIBUTARY SUITABILITY PLOTS

Plots used to assess, on a biweekly basis, suitability of tributaries in the Great Lakes basin for Asian carp spawning. Data are plotted for 220 gauging stations that had sufficient data to interpret suitability (See Table 2 and Appendix 2). Analysis was done only for stations with a minimum of five years of records. The water velocity of 0.7 m/s, is often identified as minimum flow required to trigger spawning.



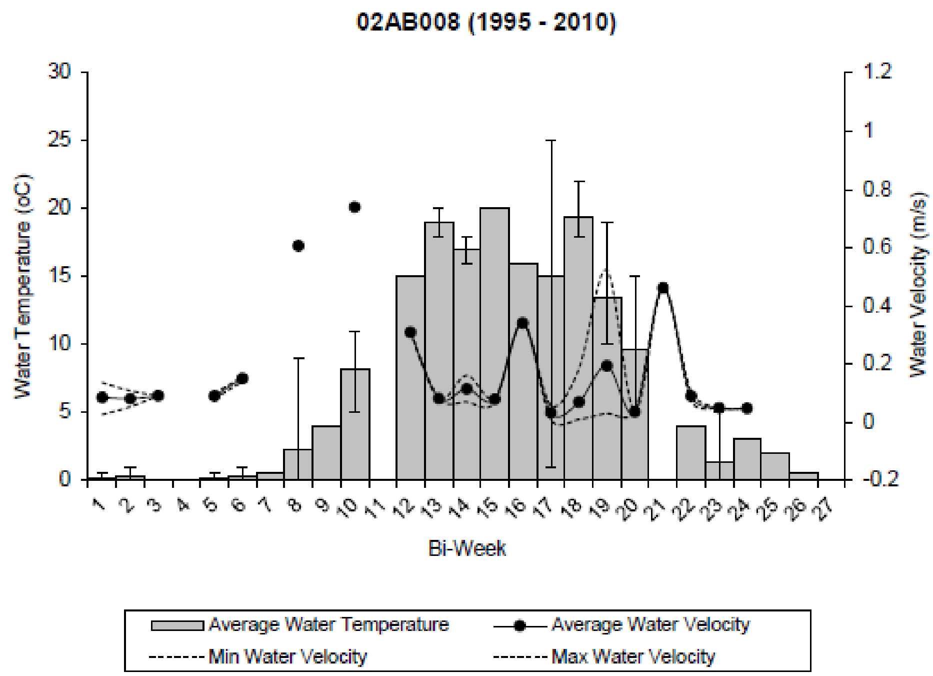
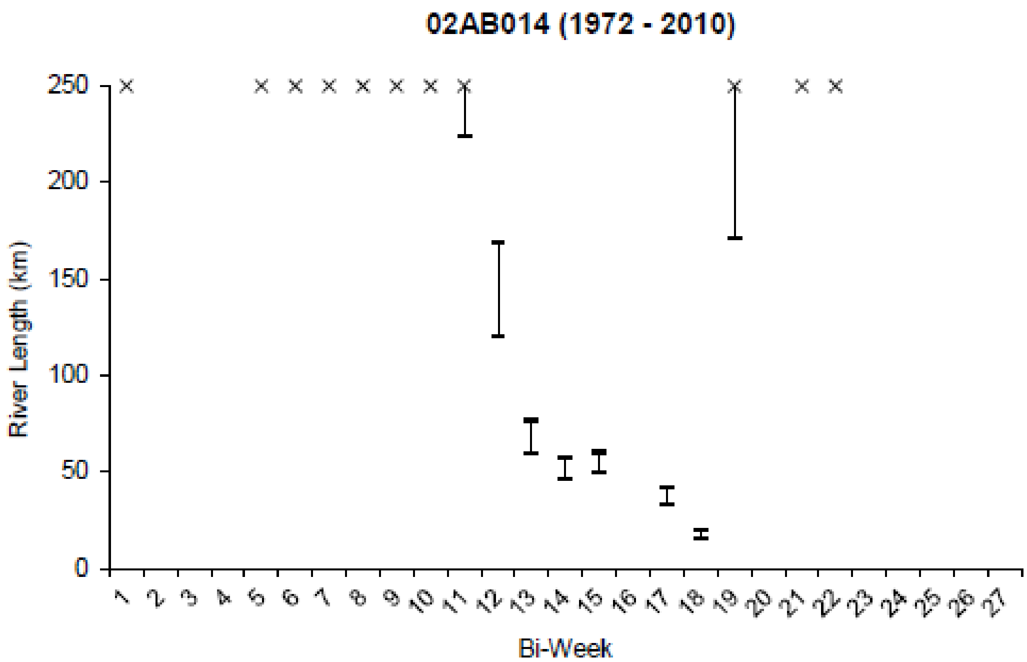


Figure A1-1. Gauging station 02AB008 data from 1995–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



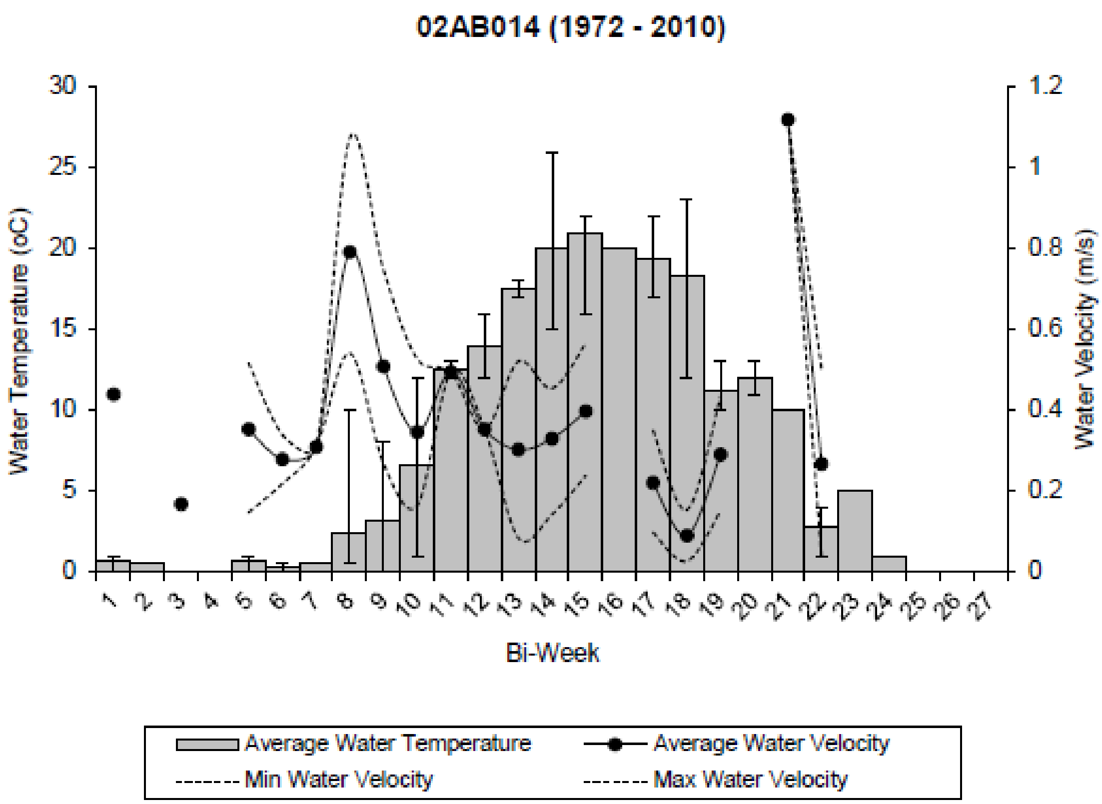
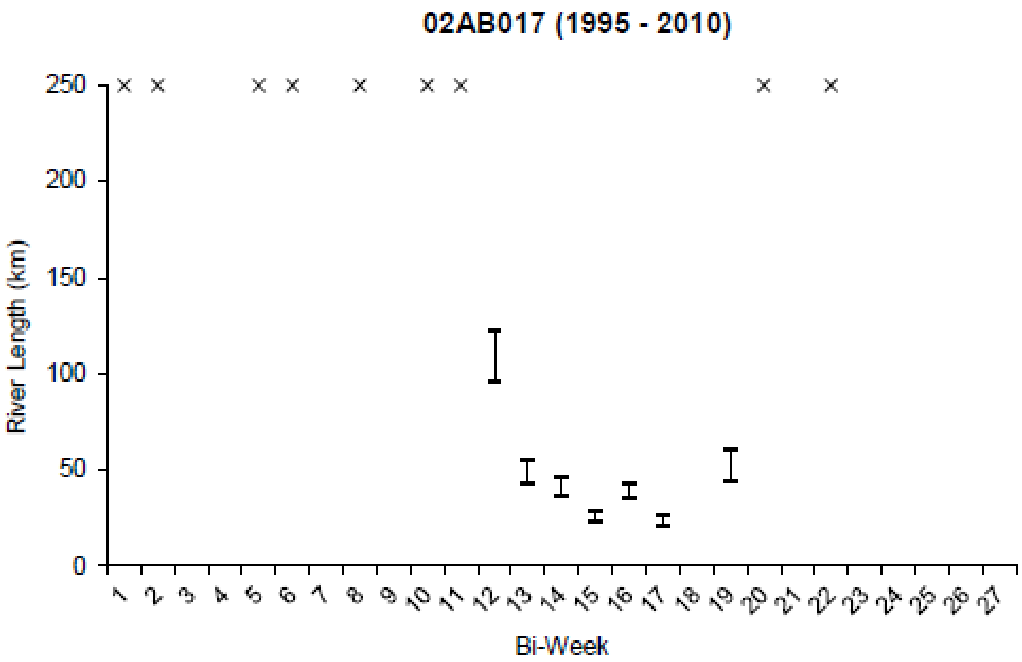


Figure A1-2. Gauging station 02AB014 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



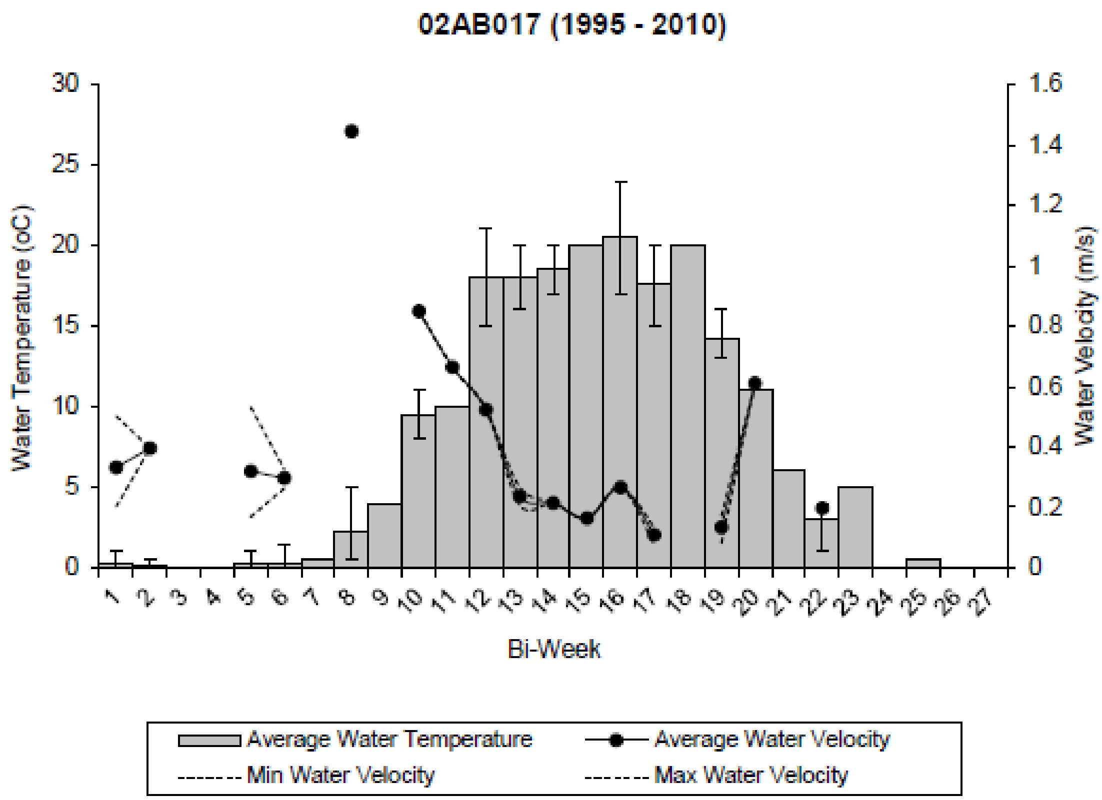
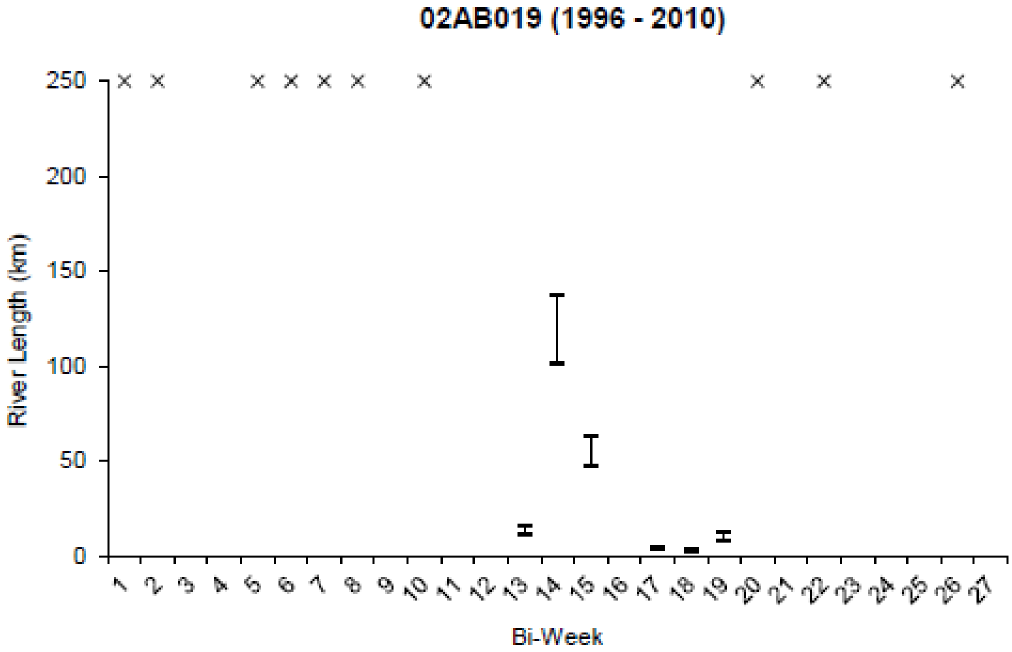


Figure A1-3. Gauging station 02AB017 data from 1995–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



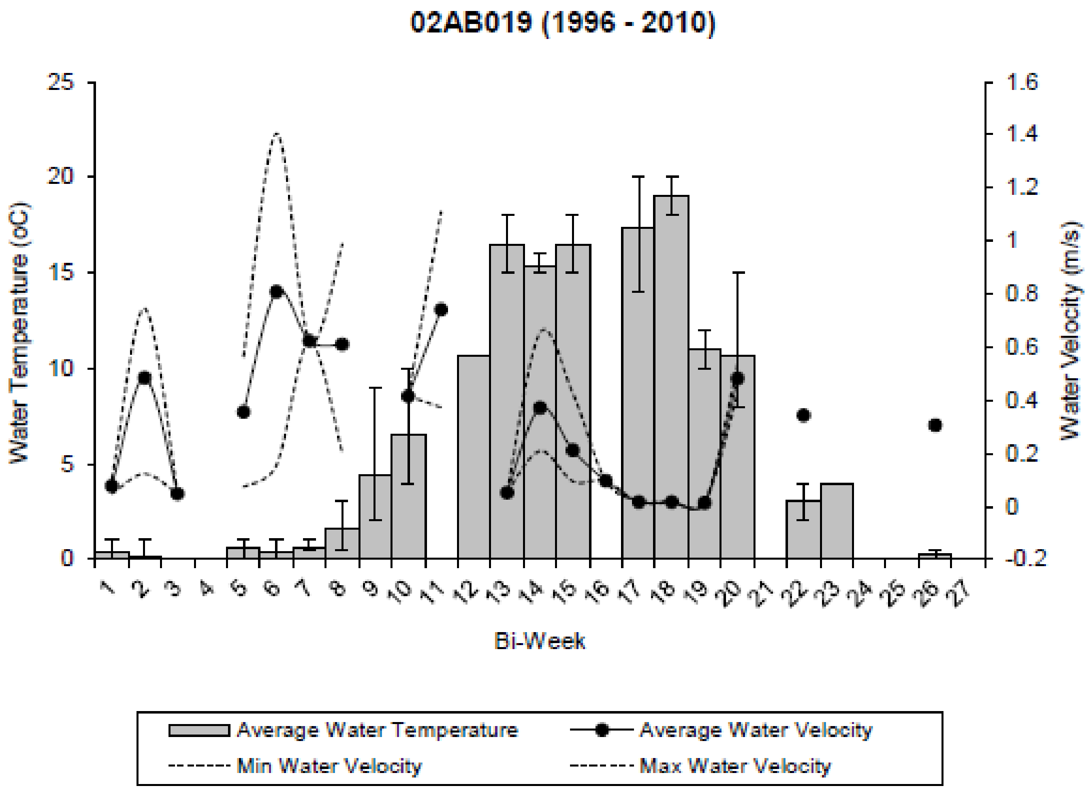
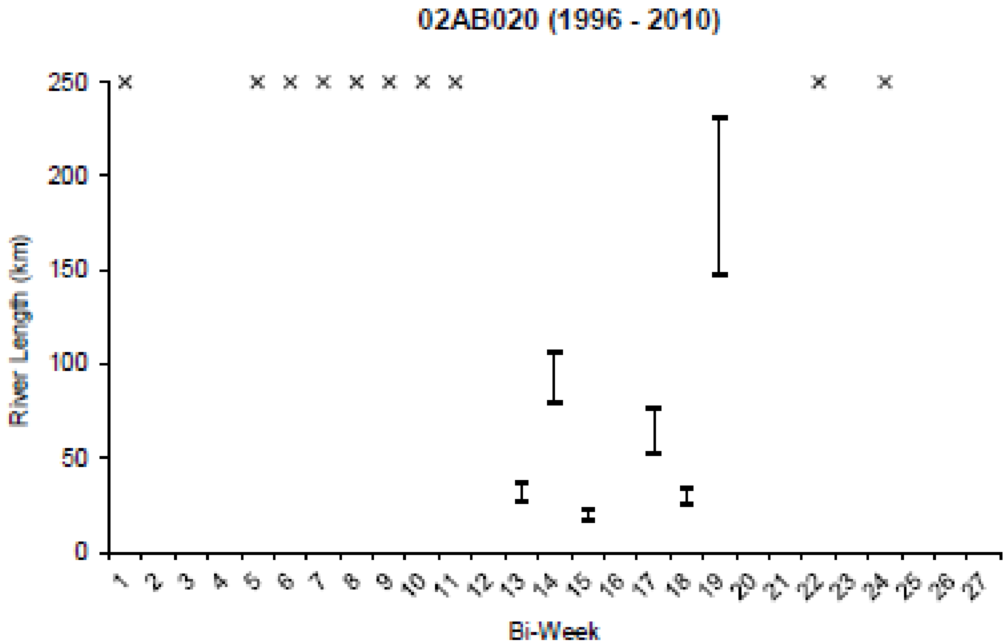


Figure A1-4. Gauging station 02AB019 data from 1996–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



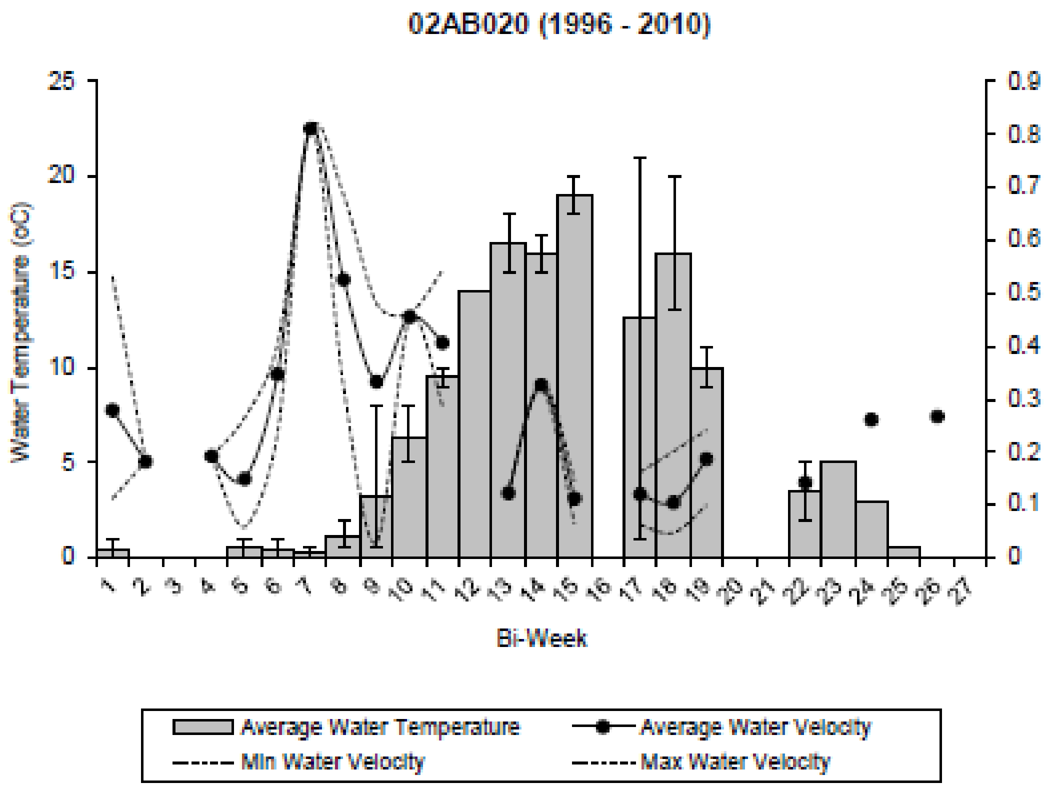
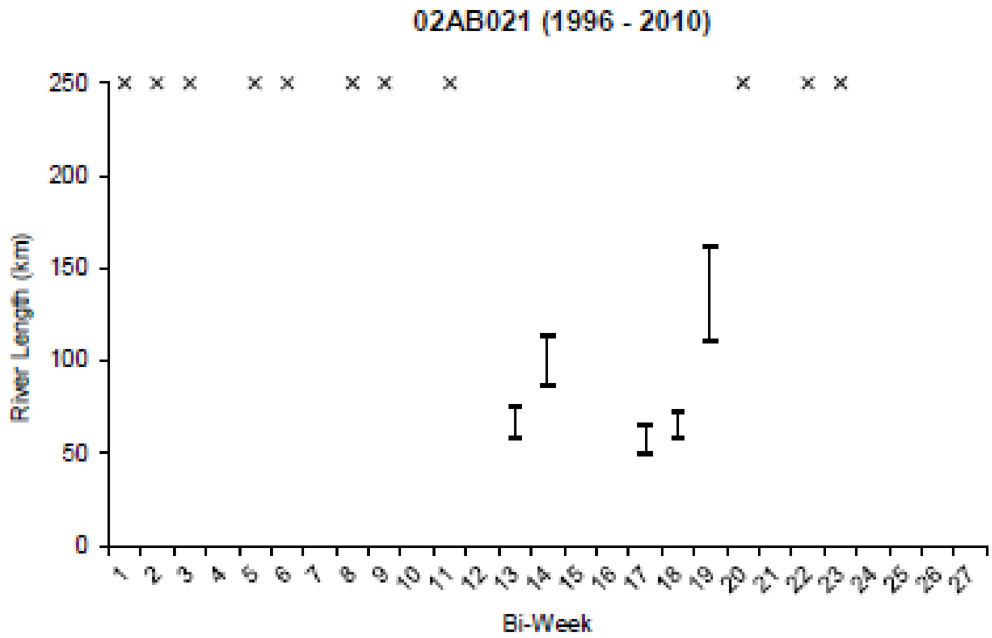


Figure A1-5. Gauging station 02AB020 data from 1996–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



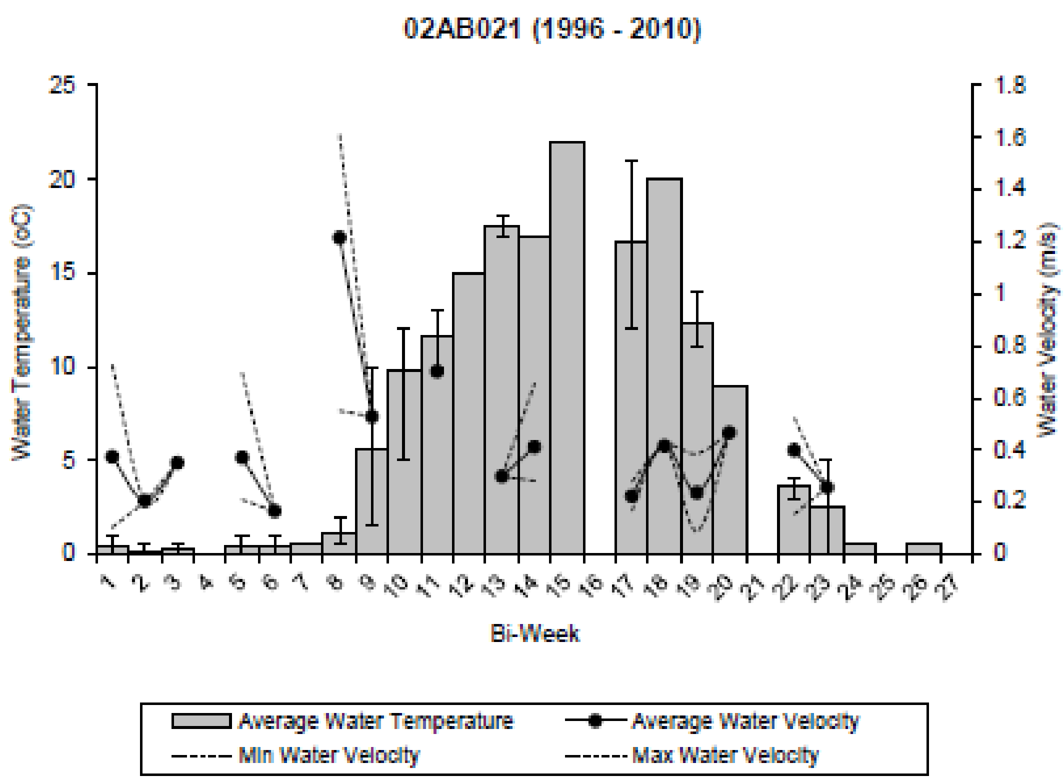
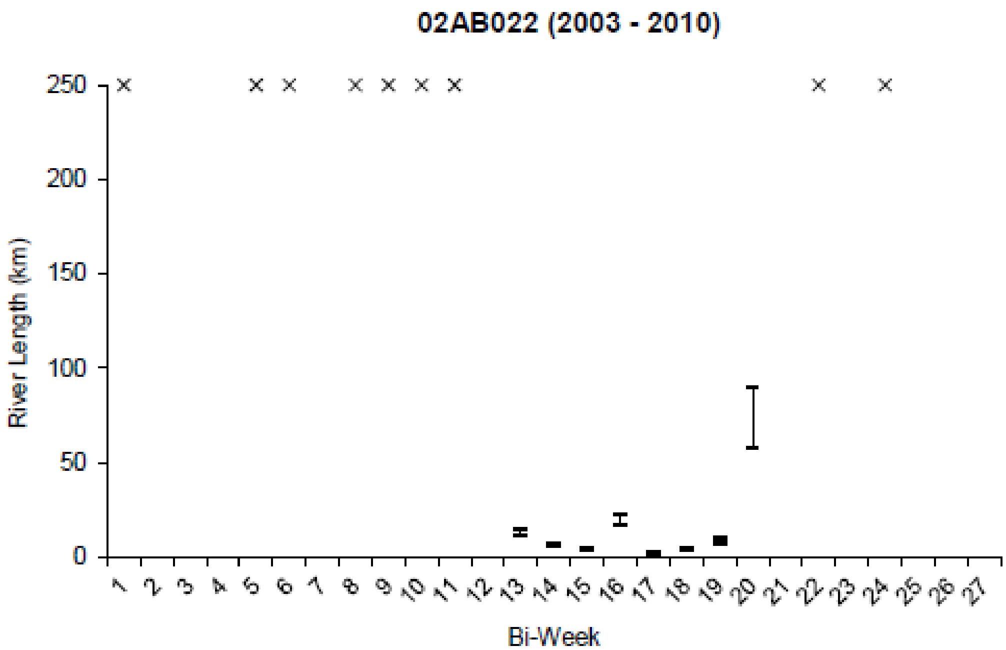


Figure A1-6. Gauging station 02AB021 data from 1996–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



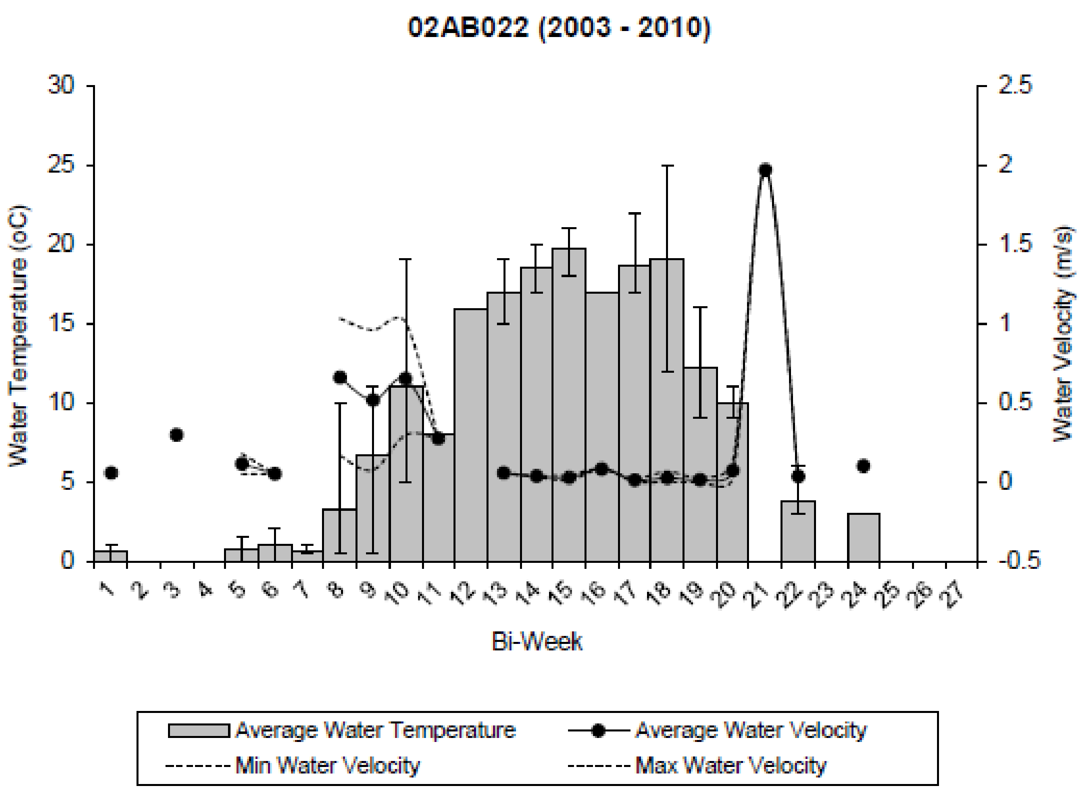
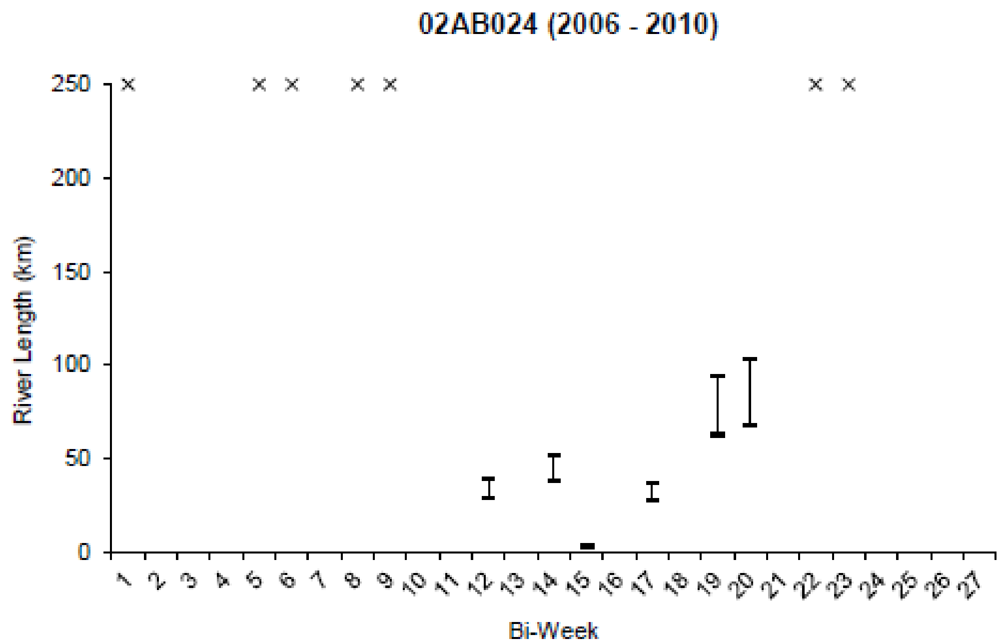


Figure A1-7. Gauging station 02AB022 data from 2003–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



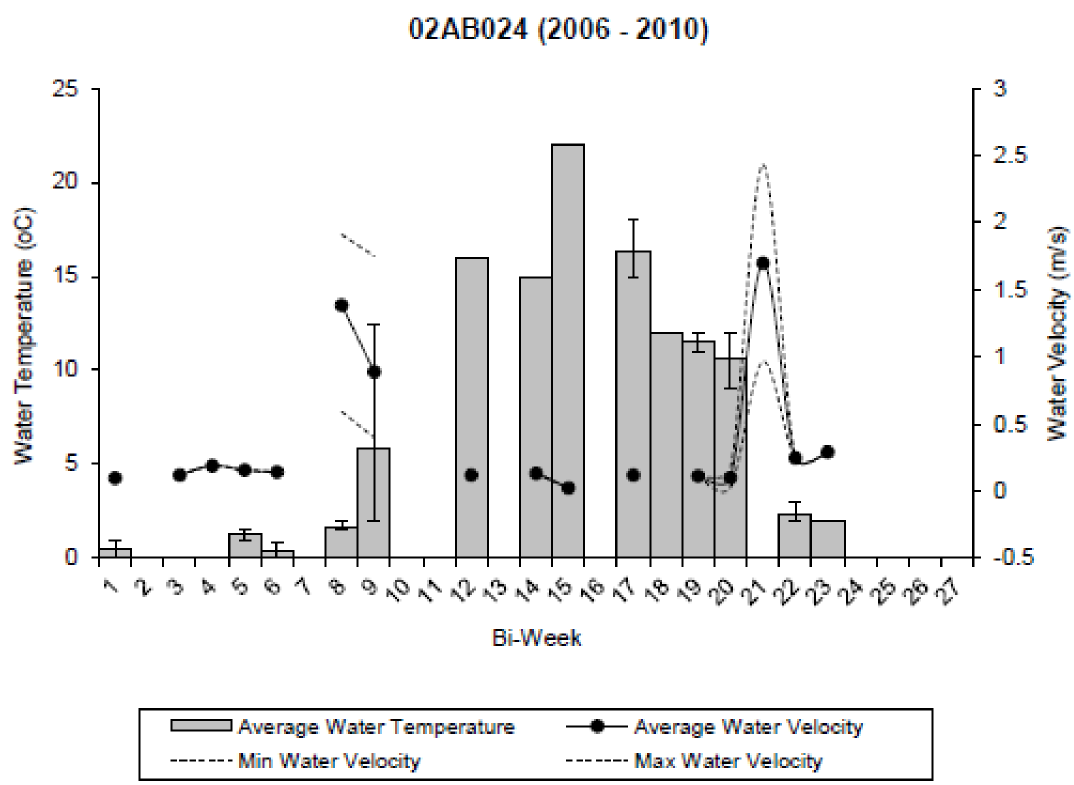


Figure A1-8. Gauging station 02AB024 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

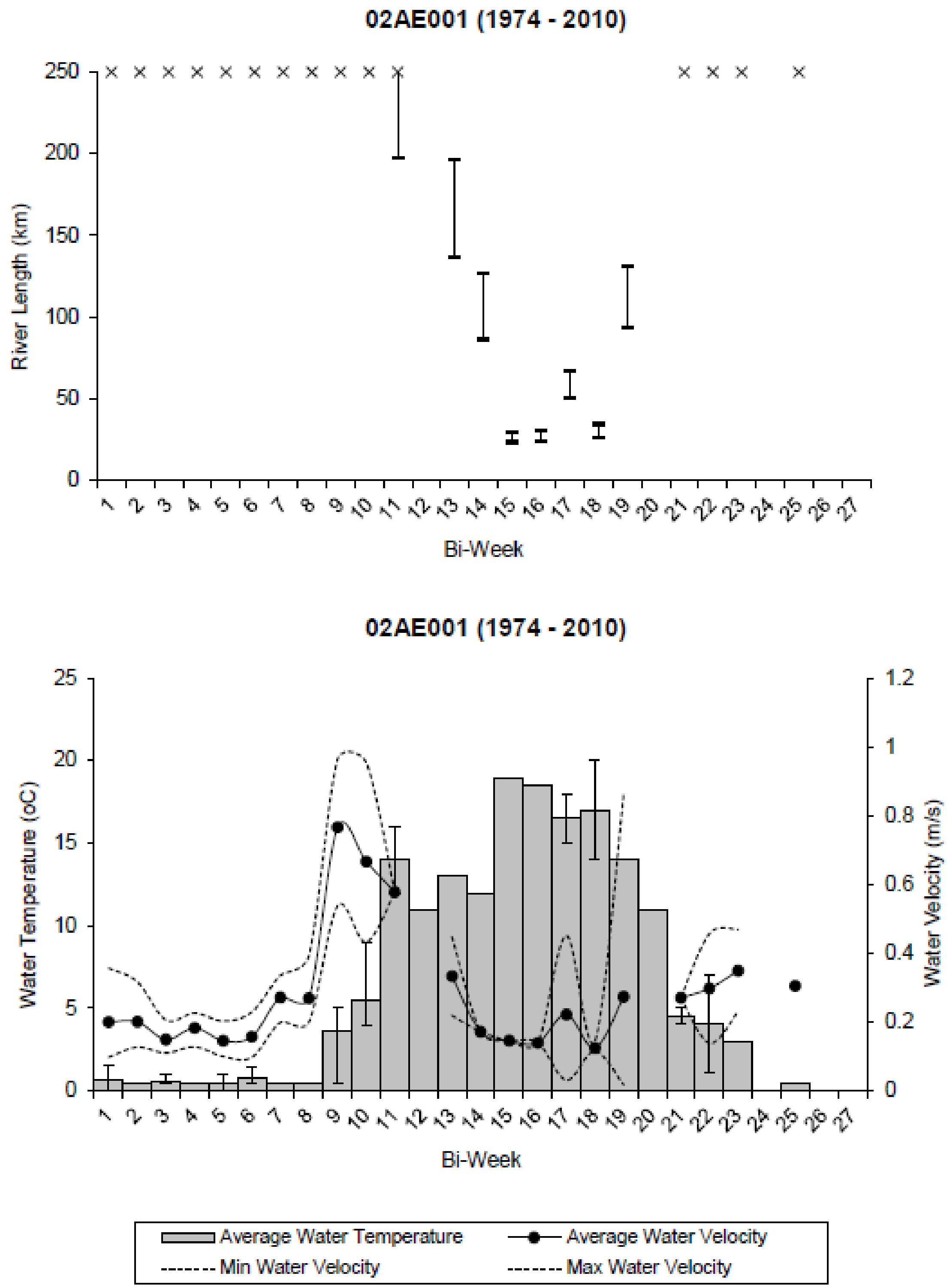
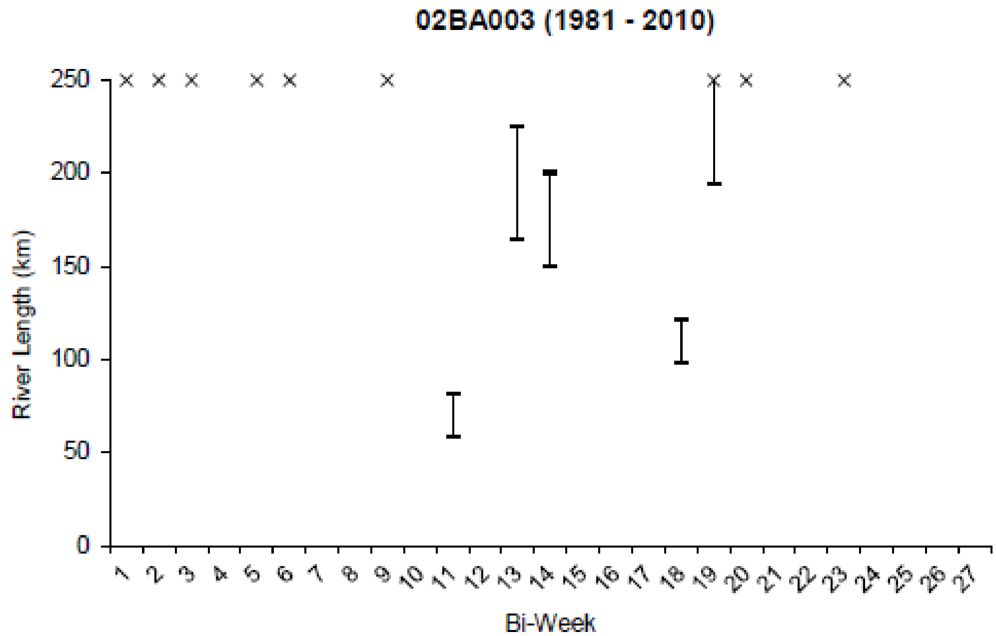


Figure A1-9. Gauging station 02AE001 data from 1974–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



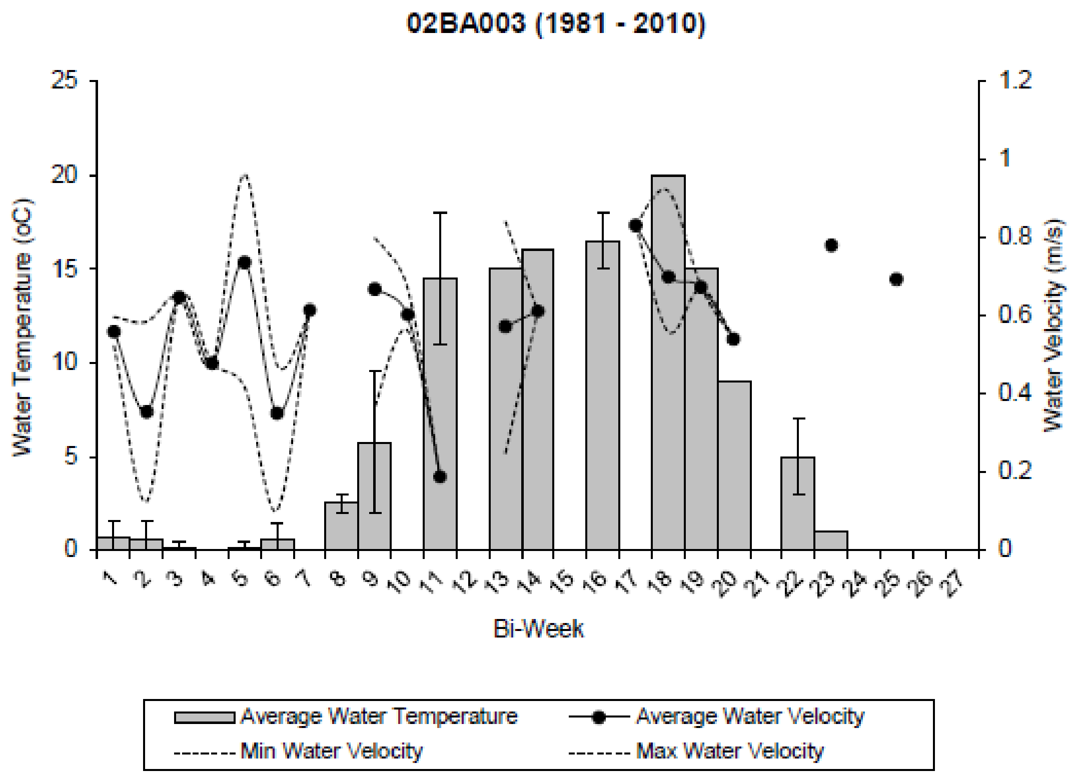
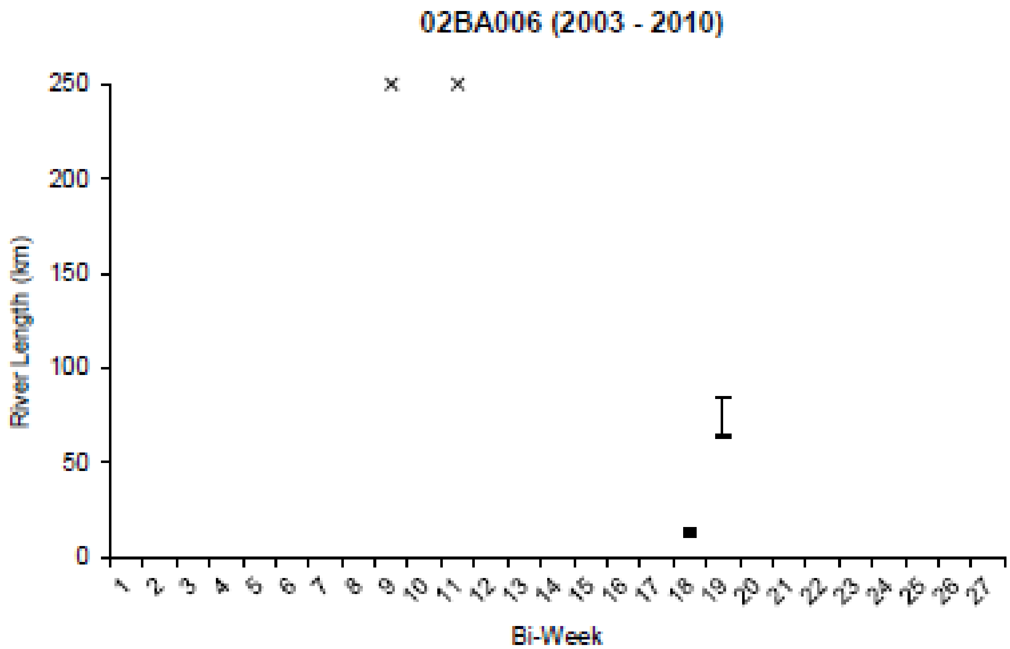


Figure A1-10. Gauging station 02BA003 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



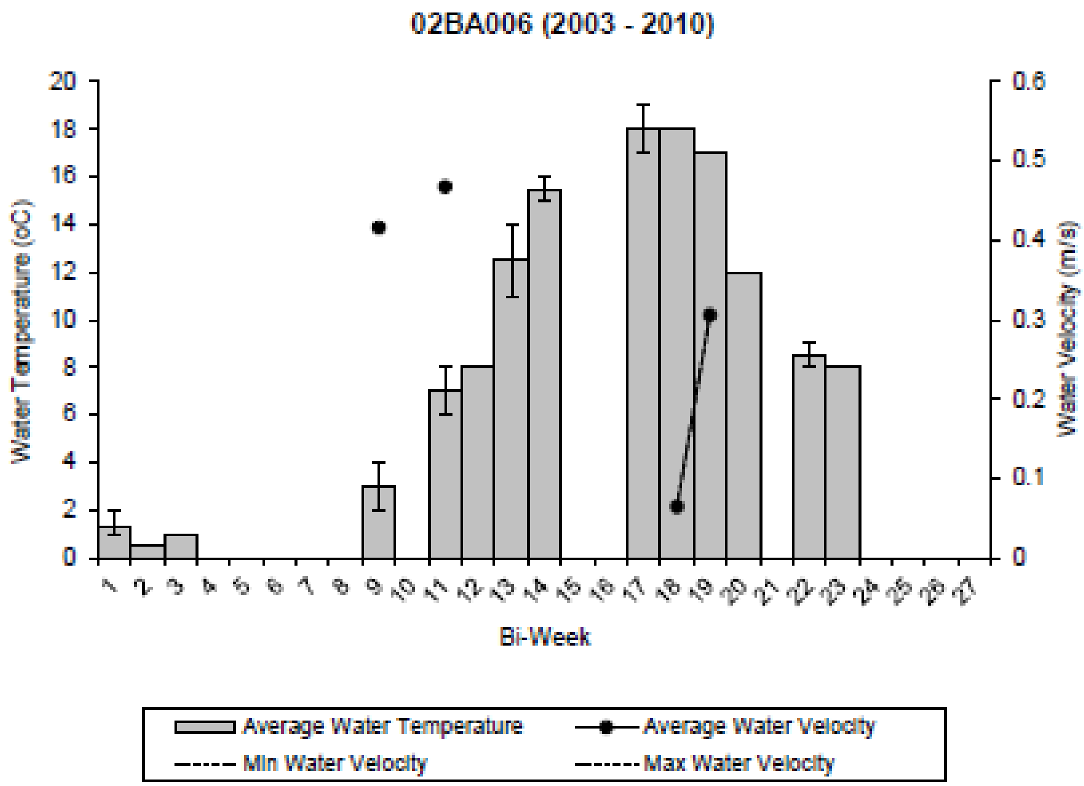


Figure A1-11. Gauging station 02BA006 data from 2003–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

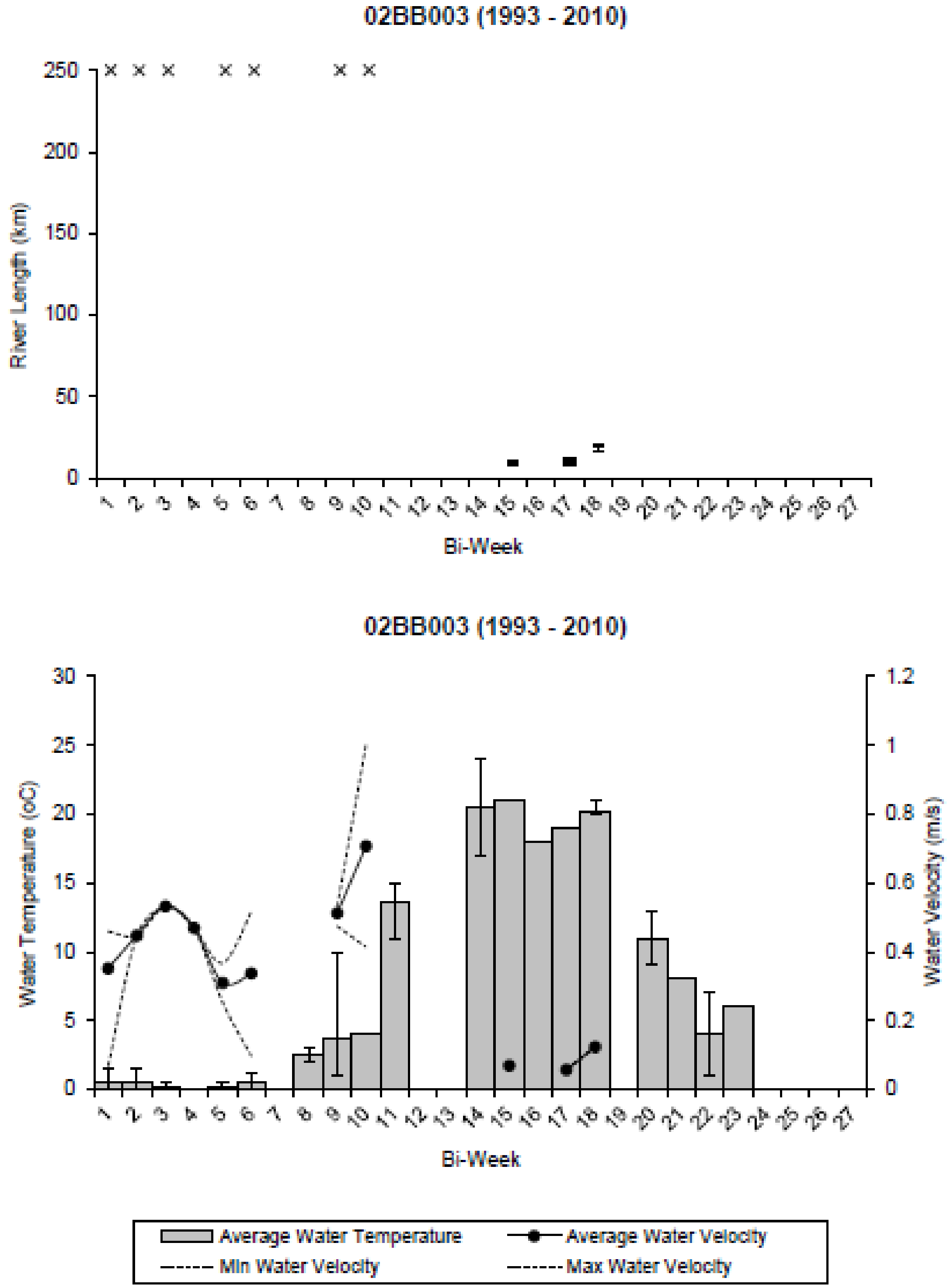


Figure A1-12. Gauging station 02BB003 data from 1993–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

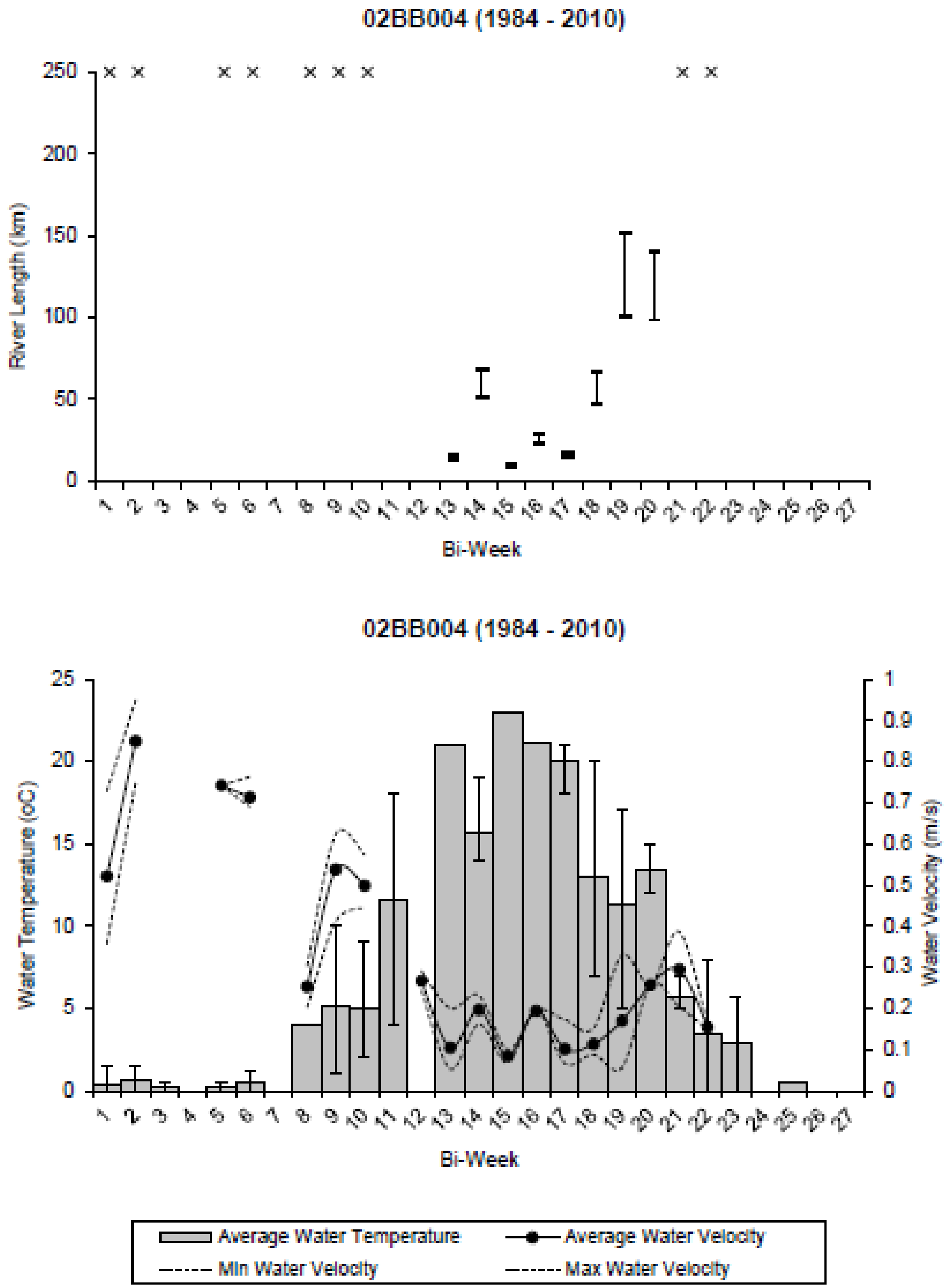
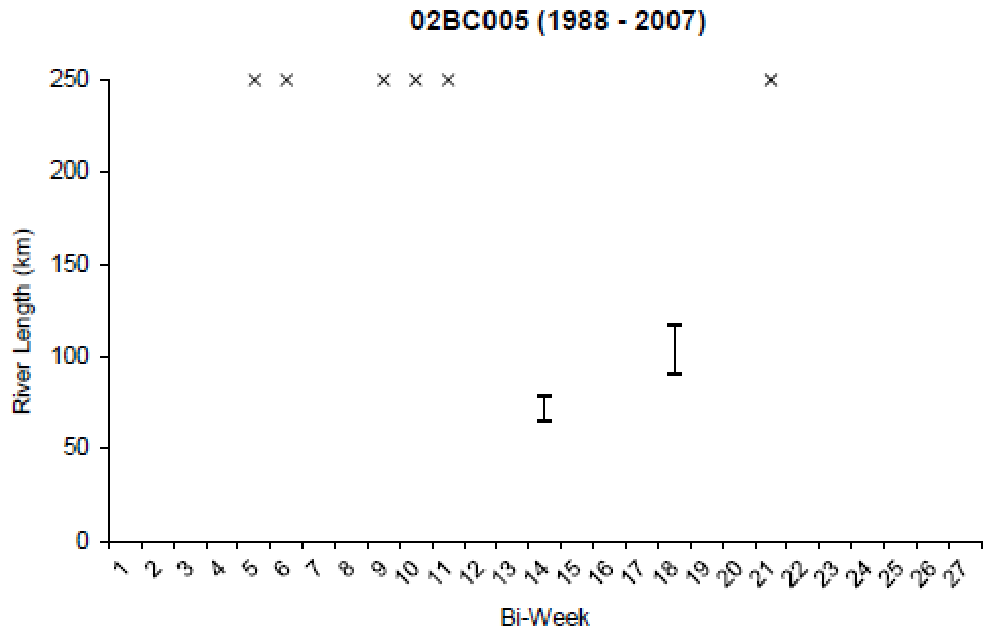


Figure A1-13. Gauging station 02BB004 data from 1984–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



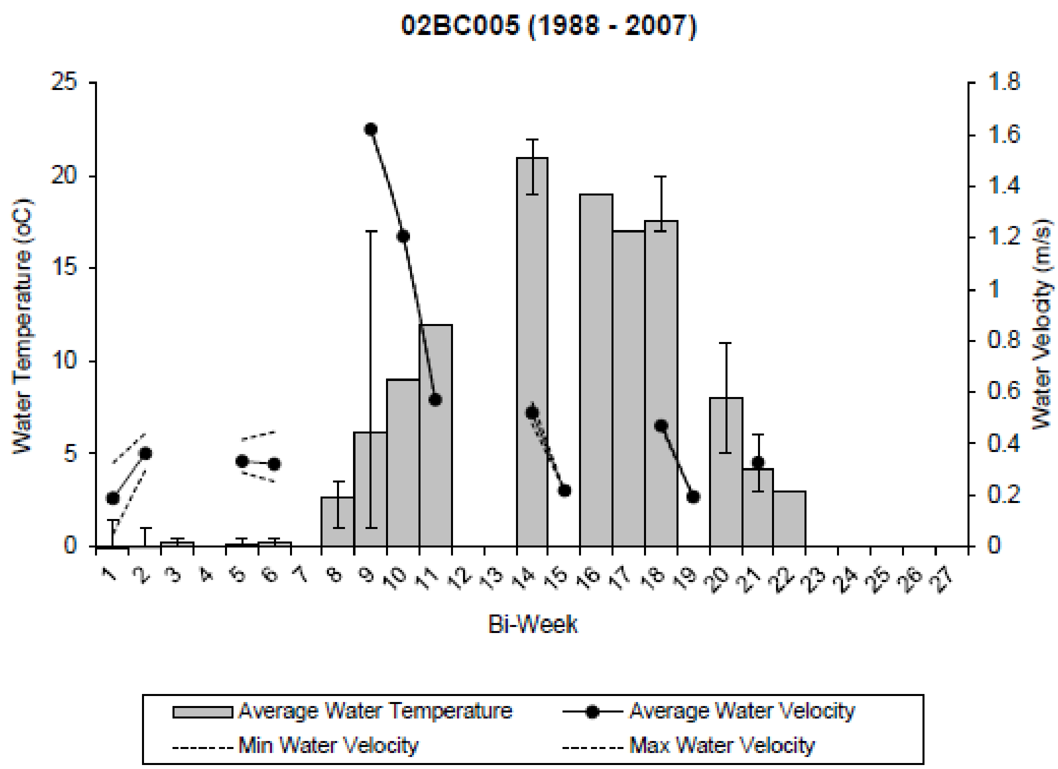
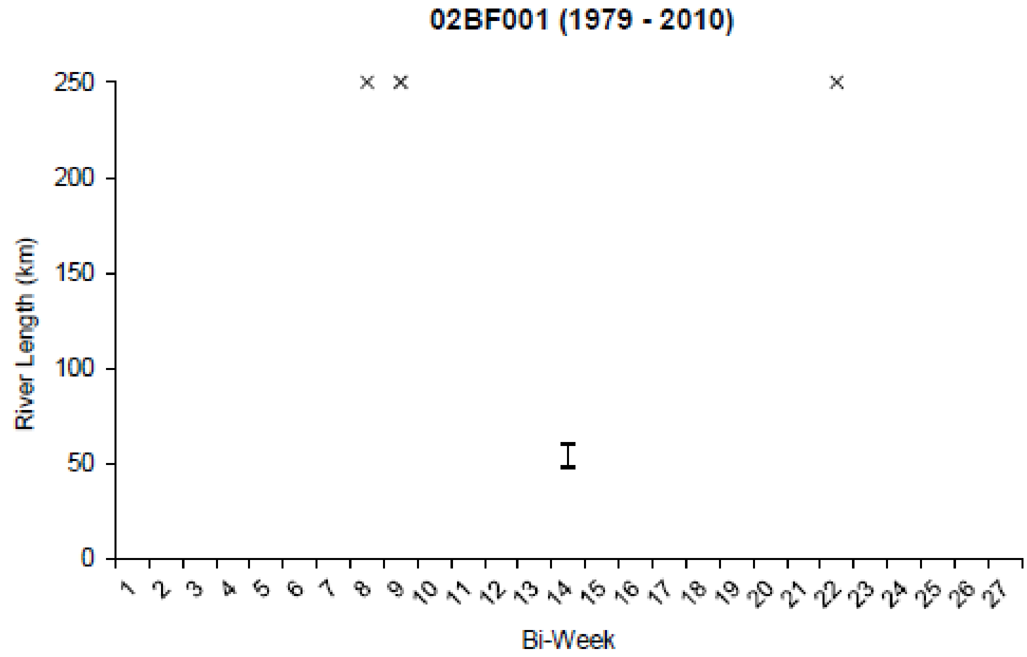


Figure A1-14. Gauging station 02BC005 data from 1998–2007. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



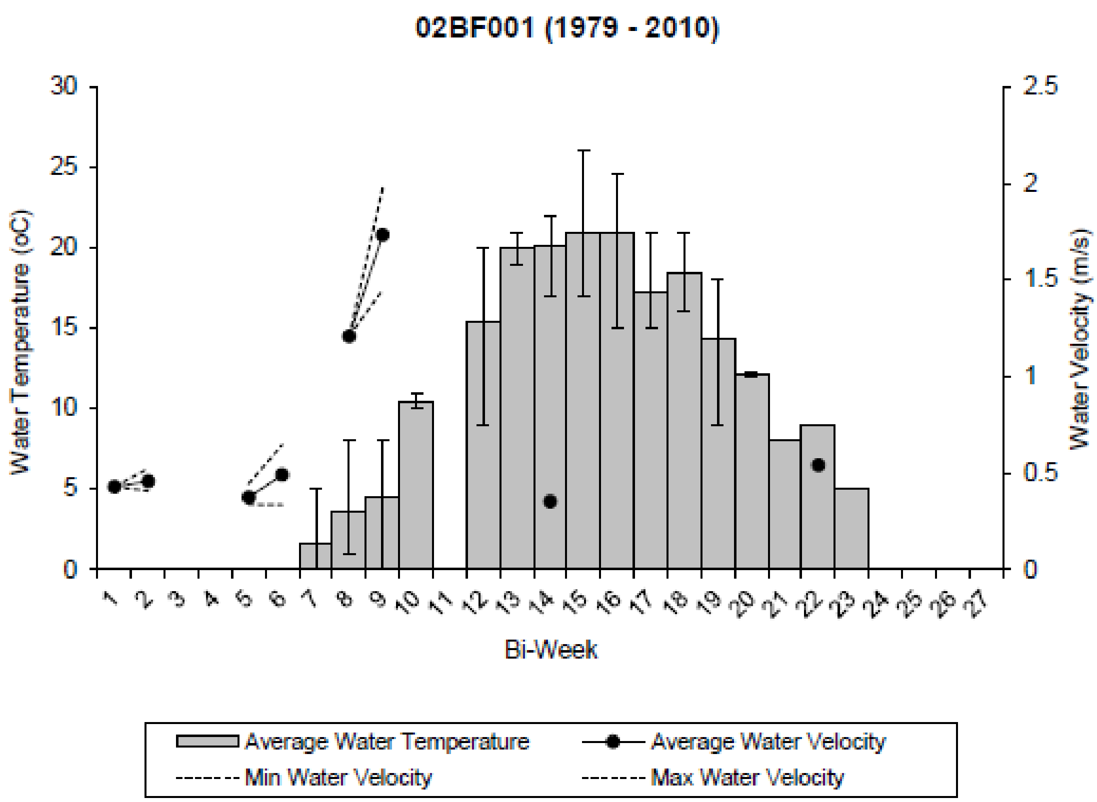
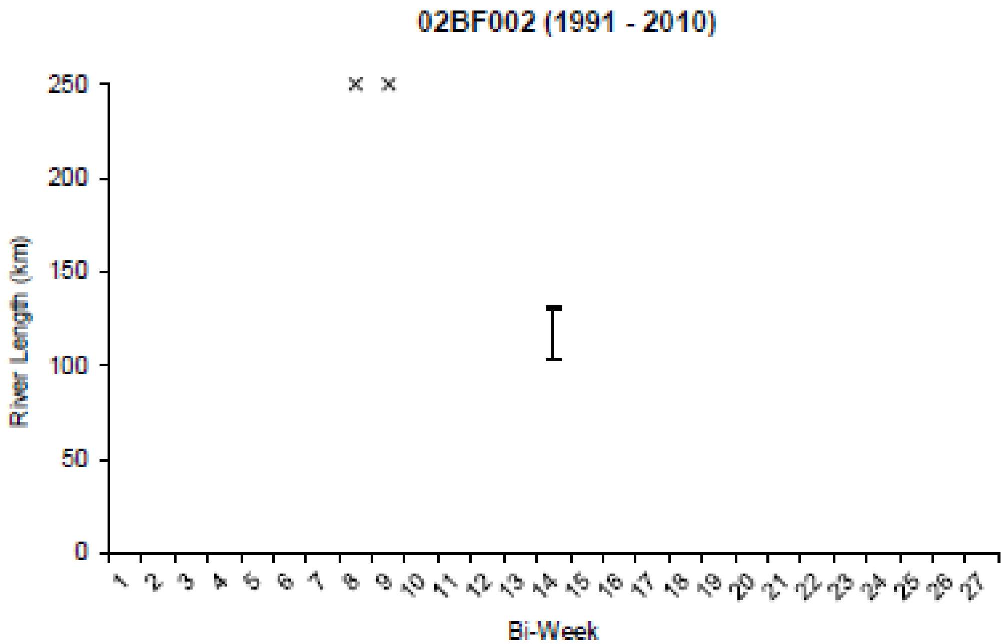


Figure A1-15. Gauging station 02BF001 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



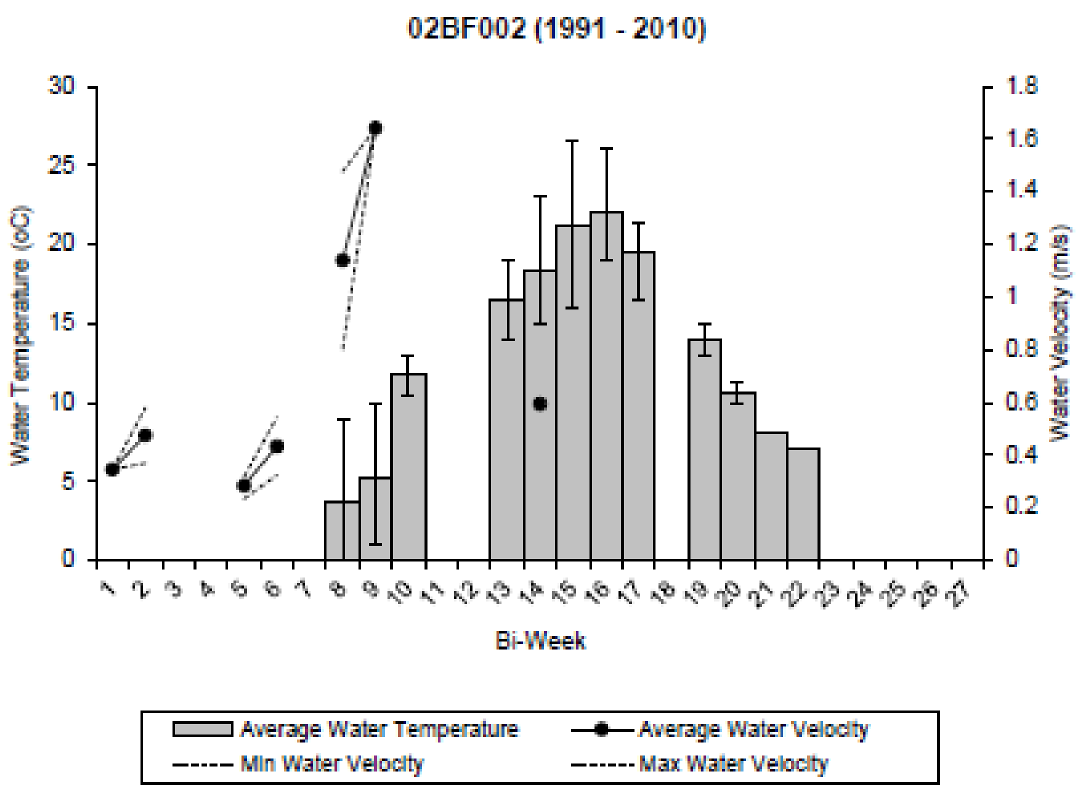
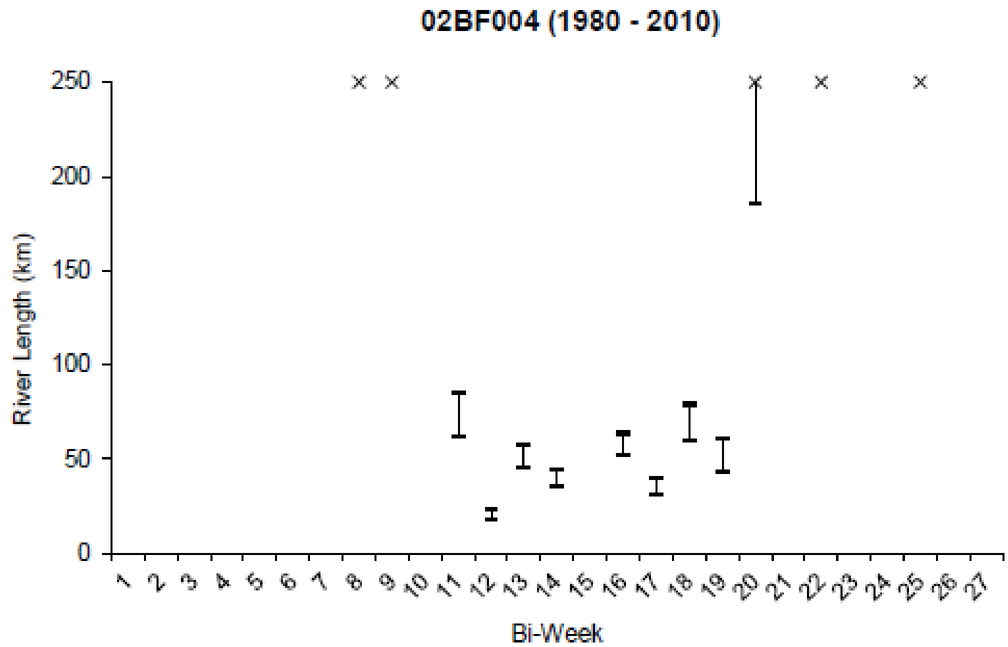


Figure A1-16. Gauging station 02BF002 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



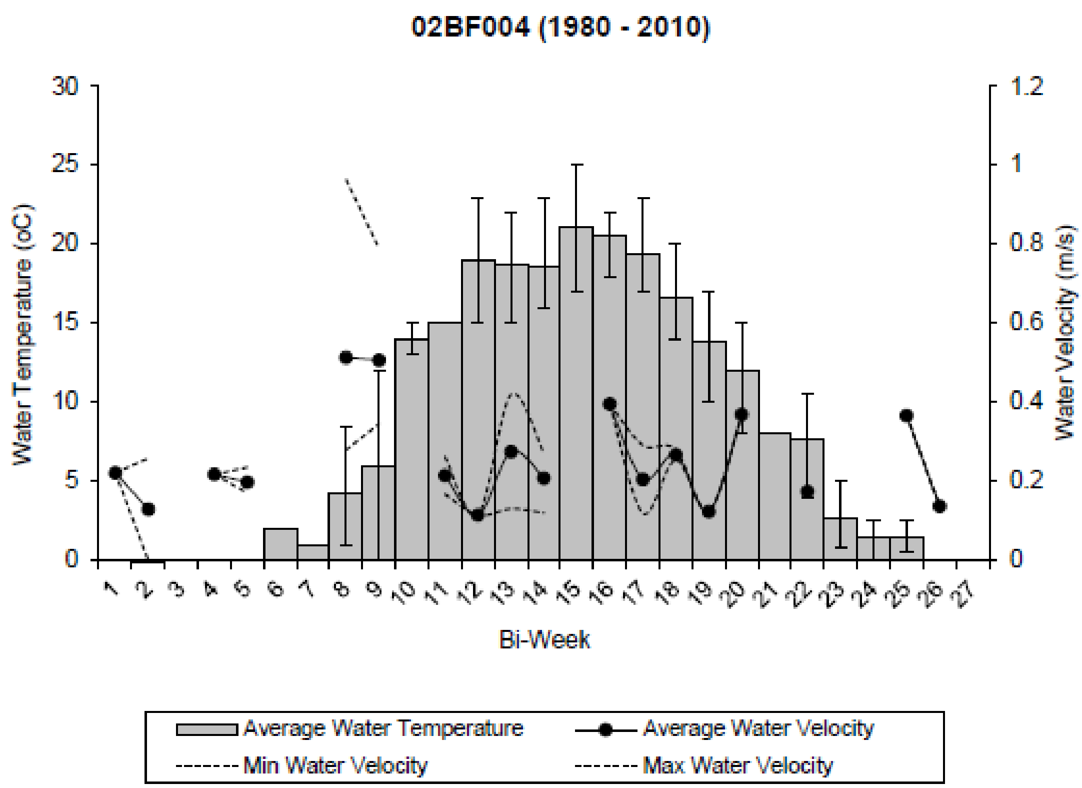
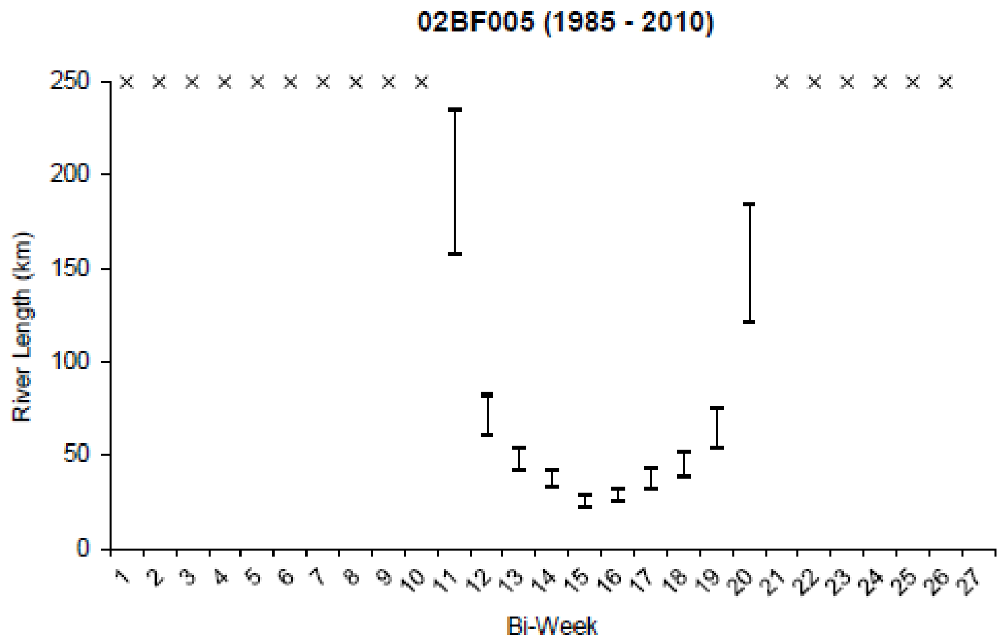


Figure A1-17. Gauging station 02BF004 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



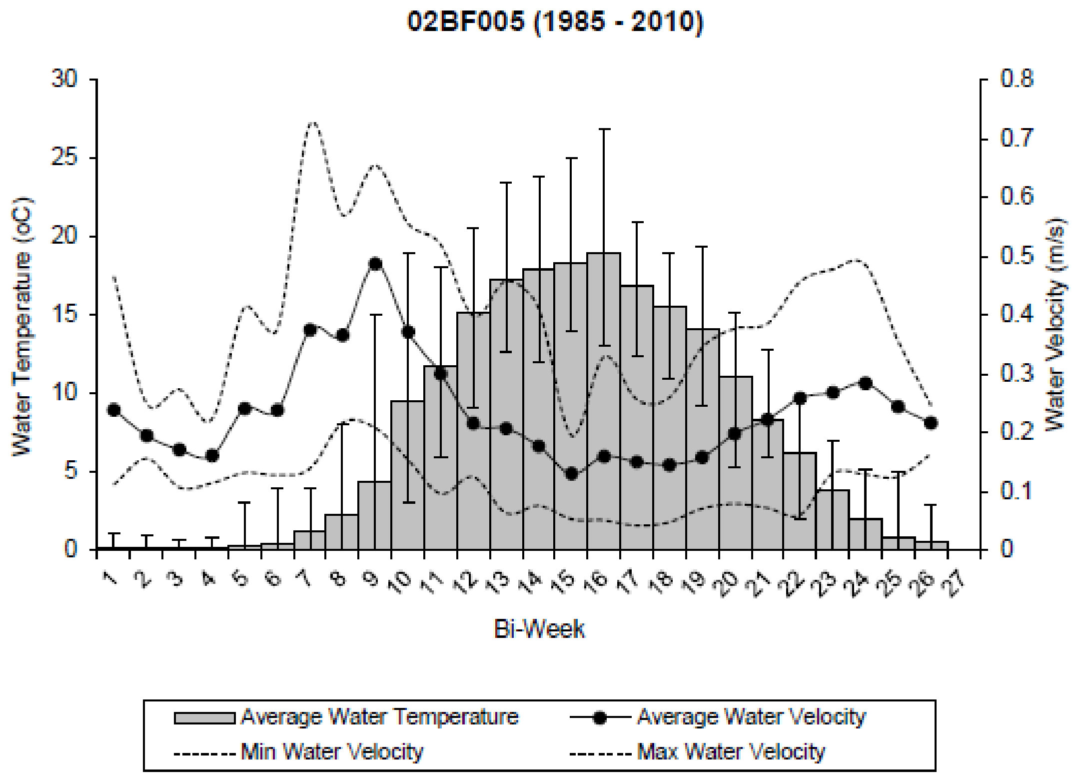
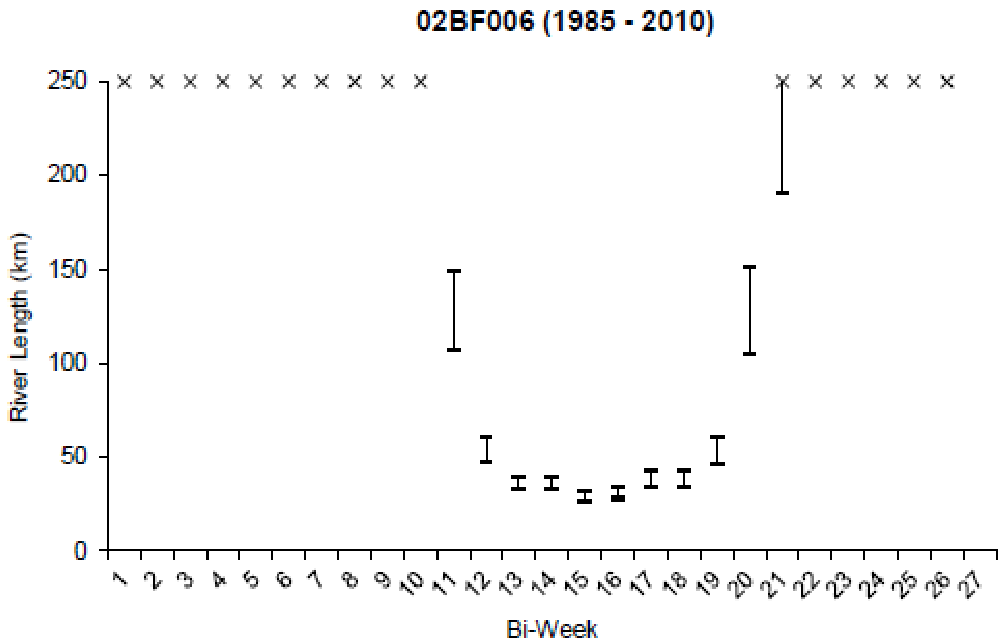


Figure A1-18. Gauging station 02BF005 data from 1985–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



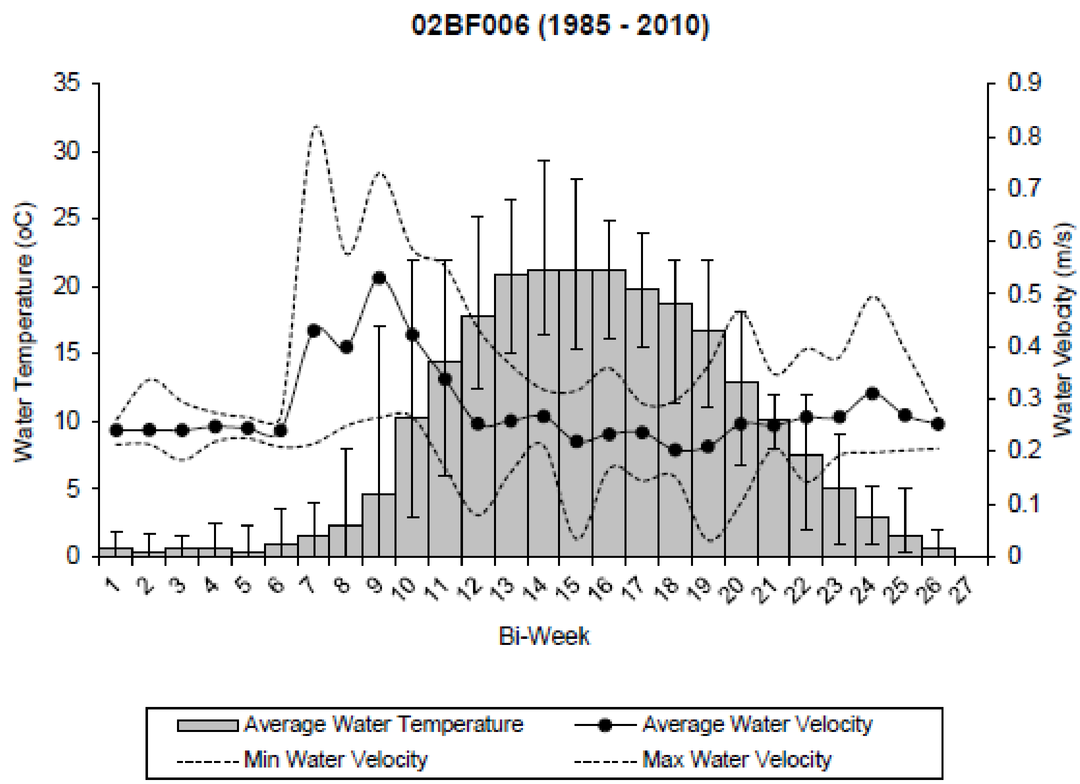
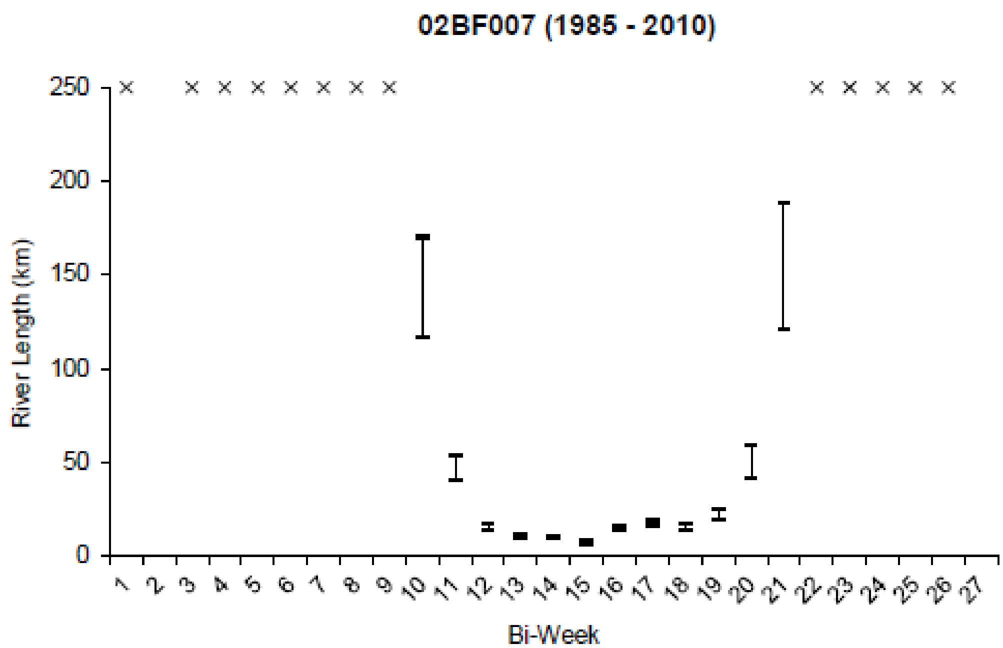


Figure A1-19. Gauging station 02BF006 data from 1985–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



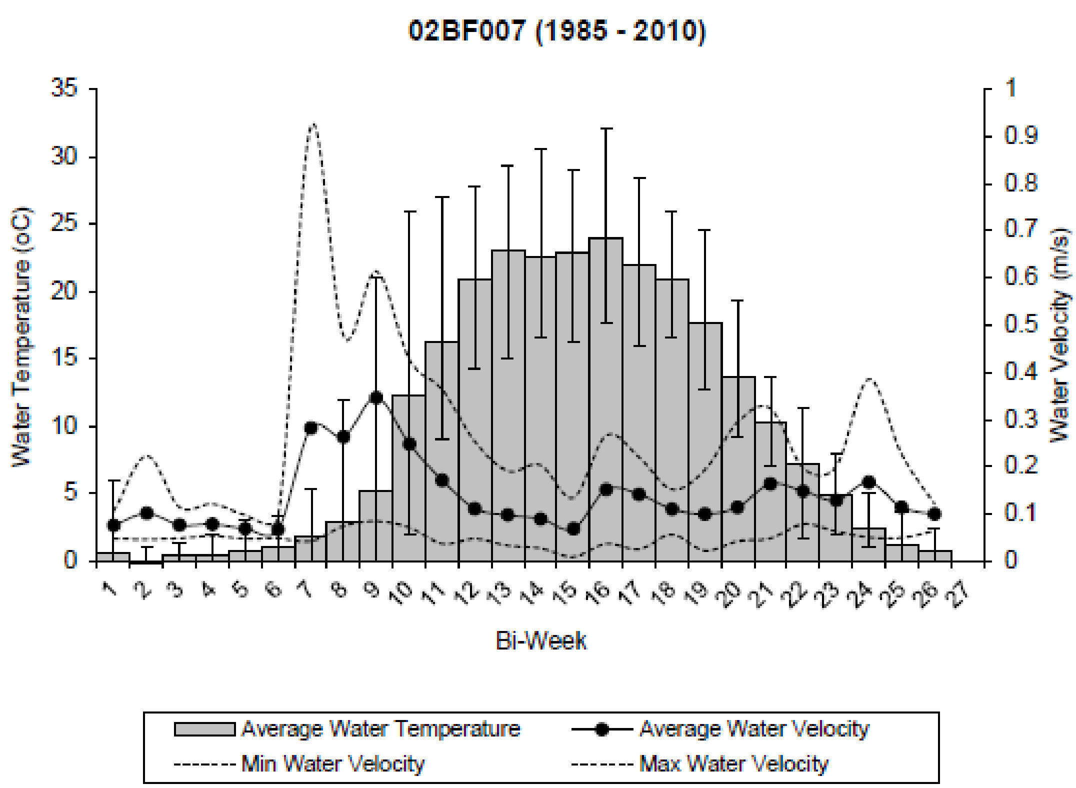
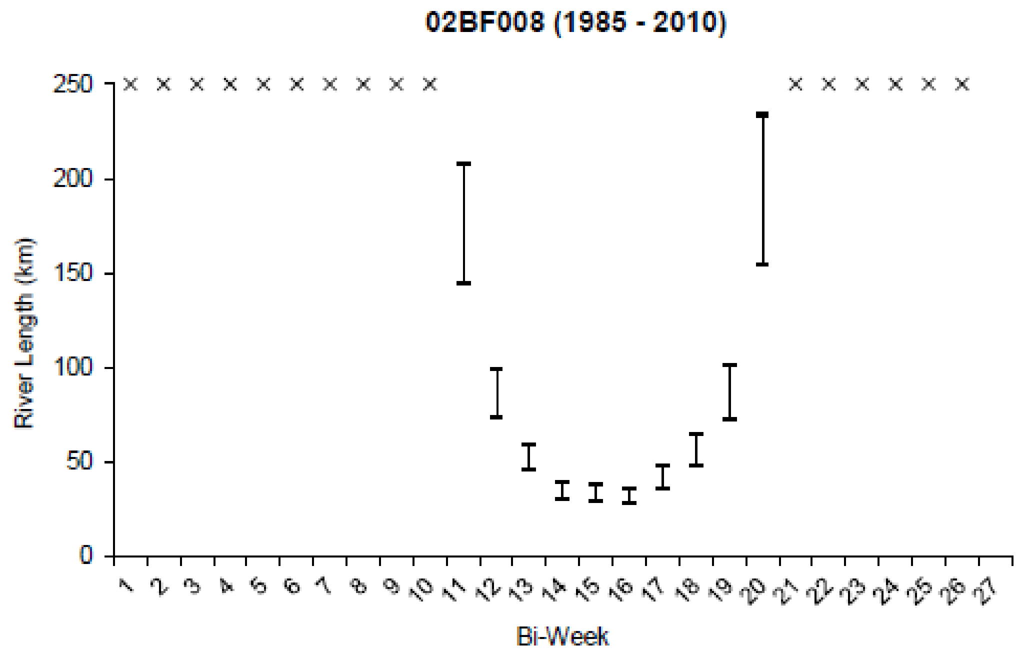


Figure A1-20. Gauging station 02BF007 data from 1985–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



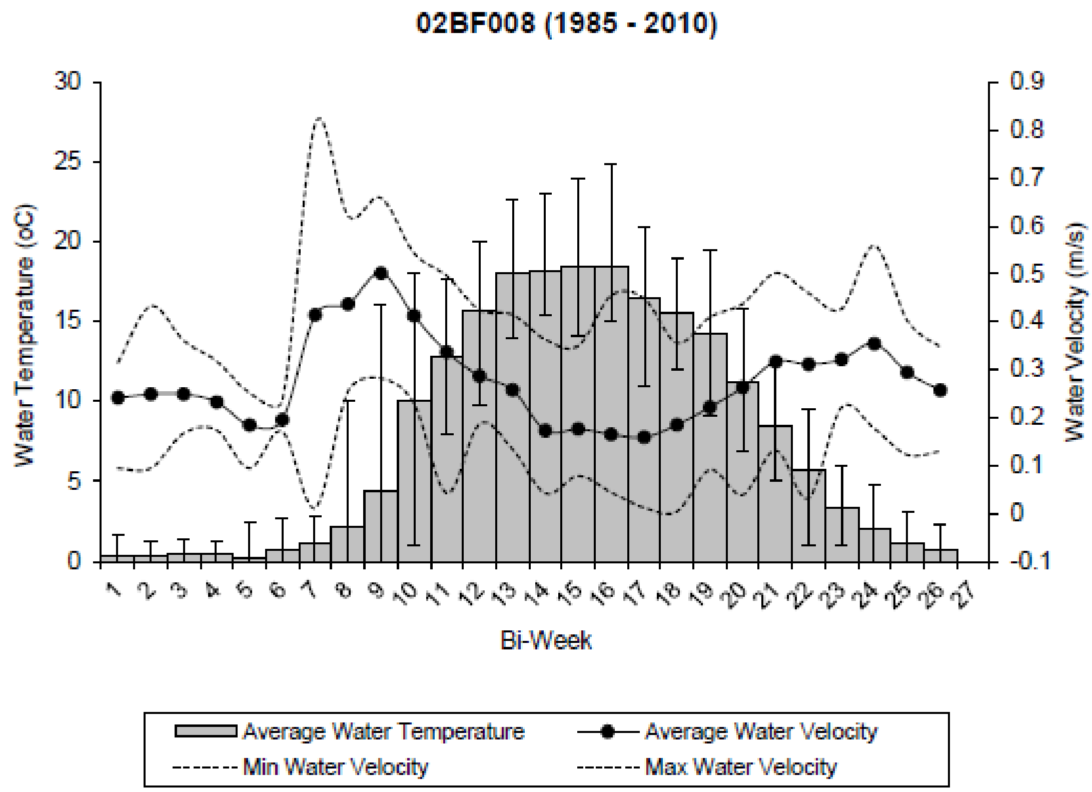
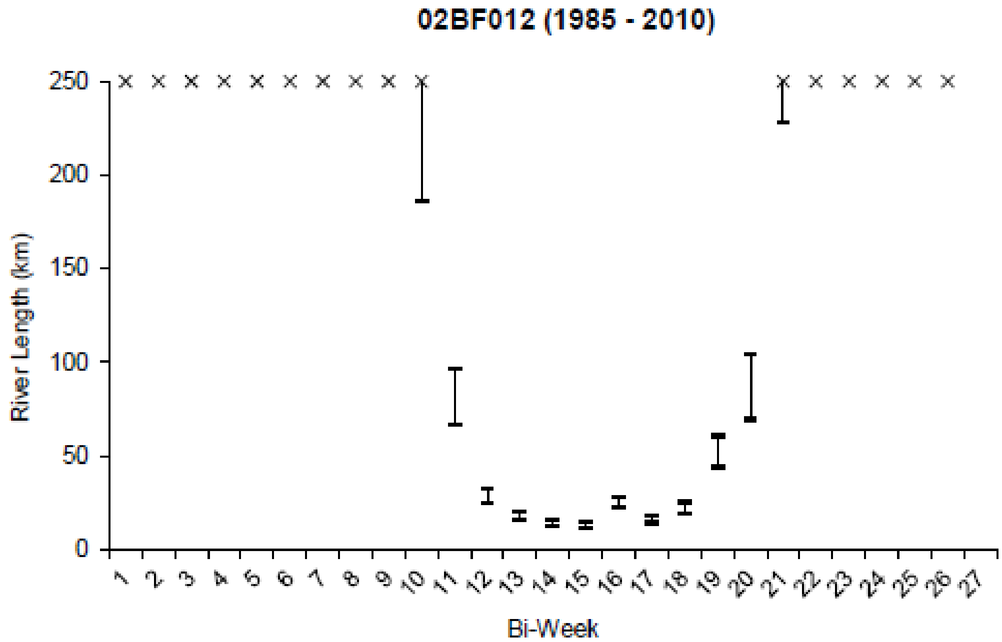


Figure A1-21. Gauging station 02BF008 data from 1985–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



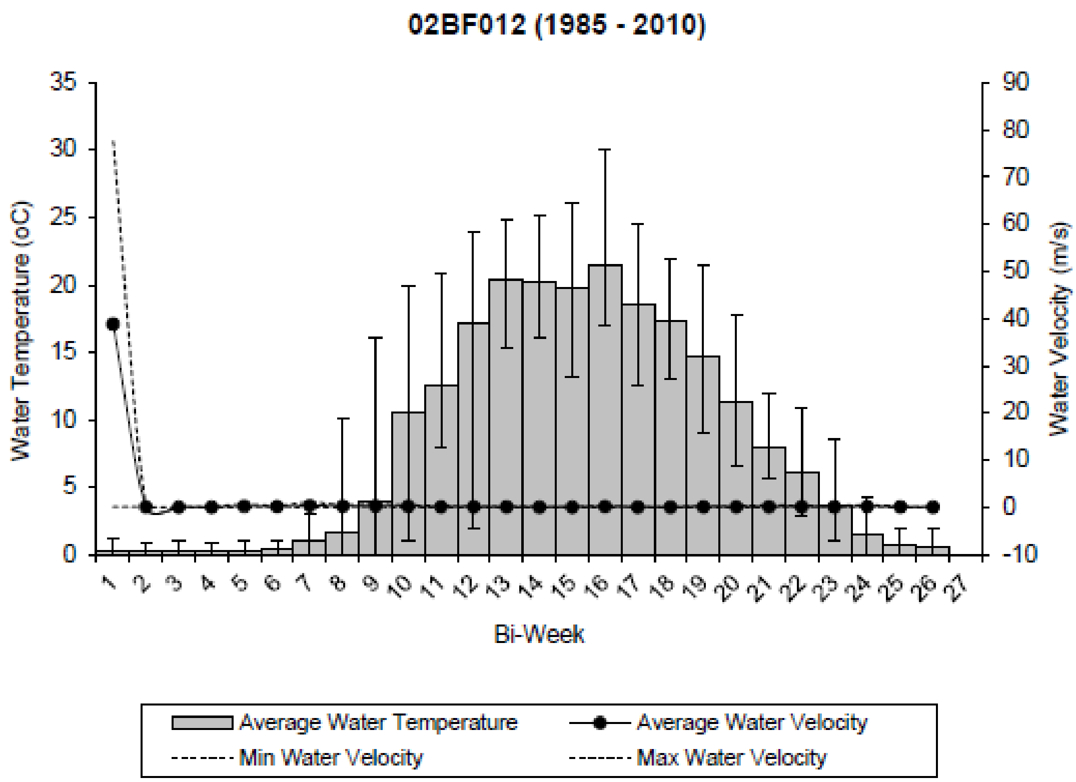
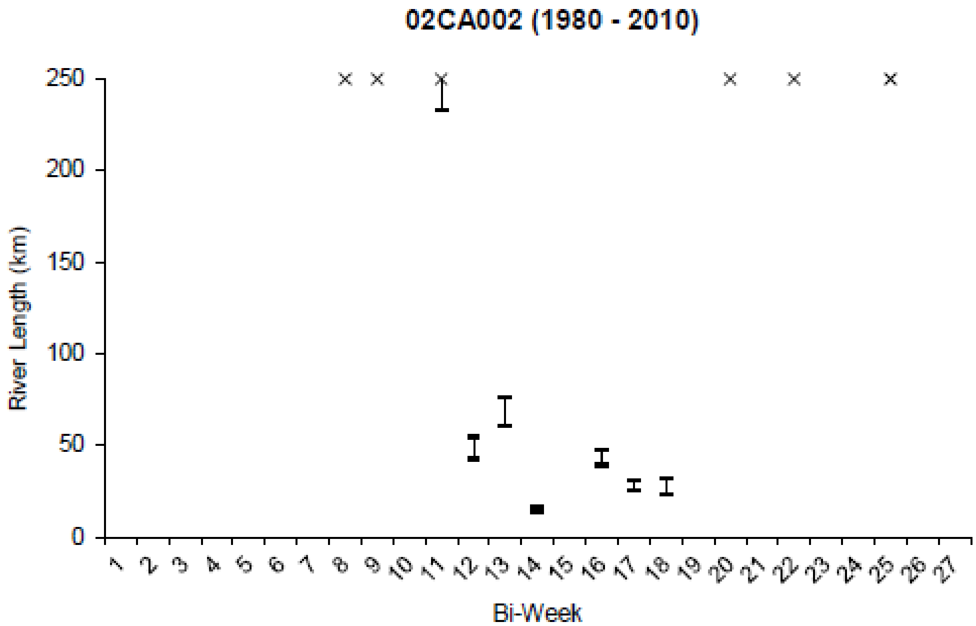


Figure A1-22. Gauging station 02BF012 data from 1985–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



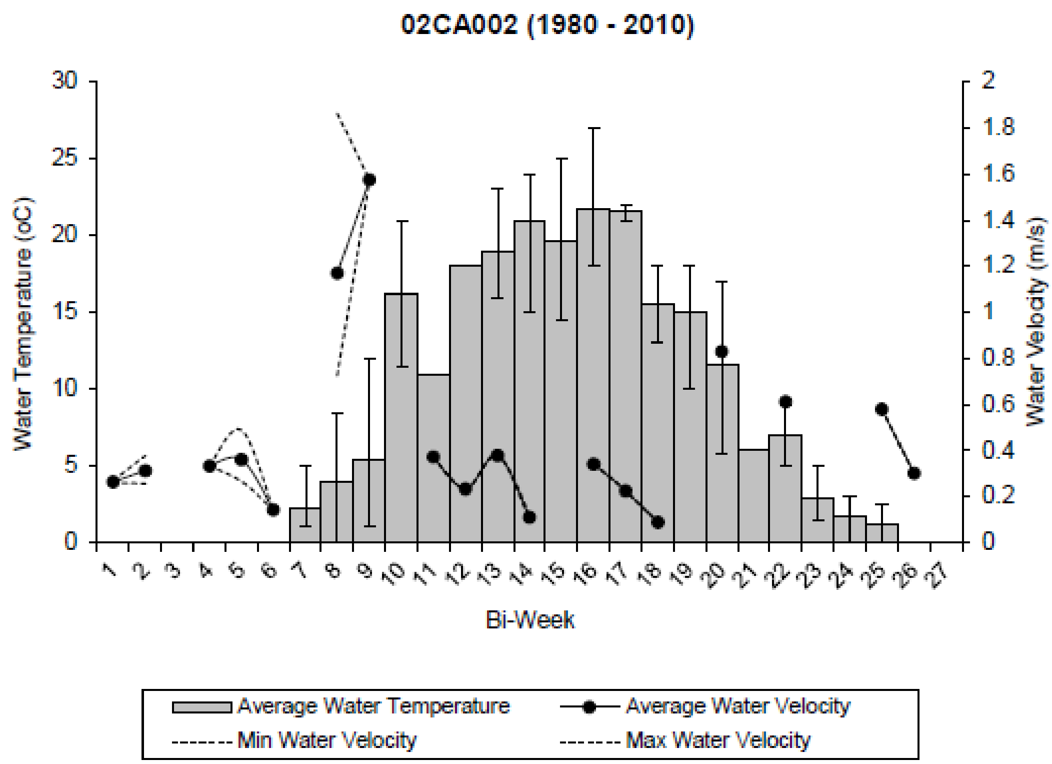


Figure A1-23. Gauging station 02CA002 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

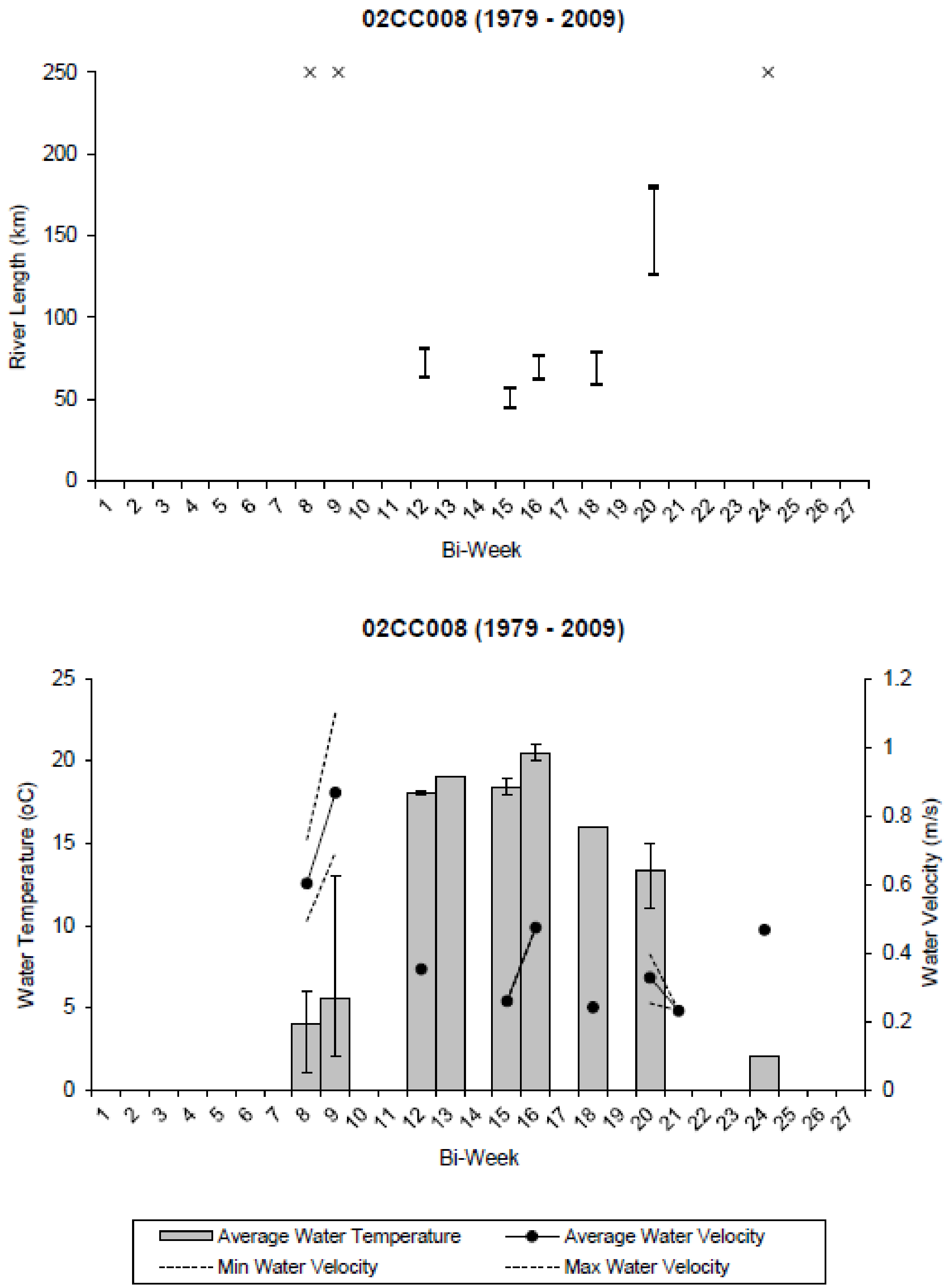


Figure A1-24. Gauging station 02CC008 data from 1979–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

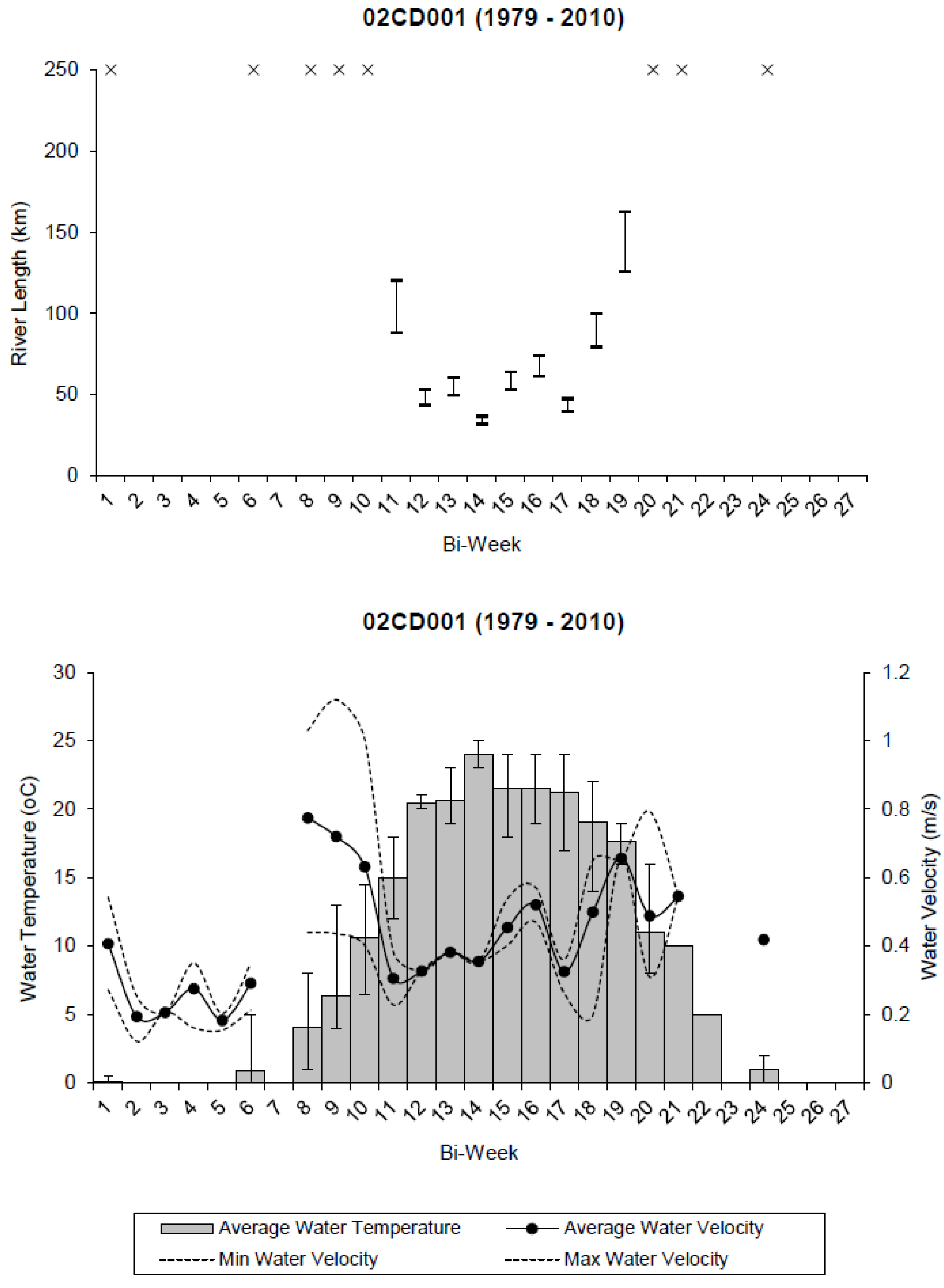
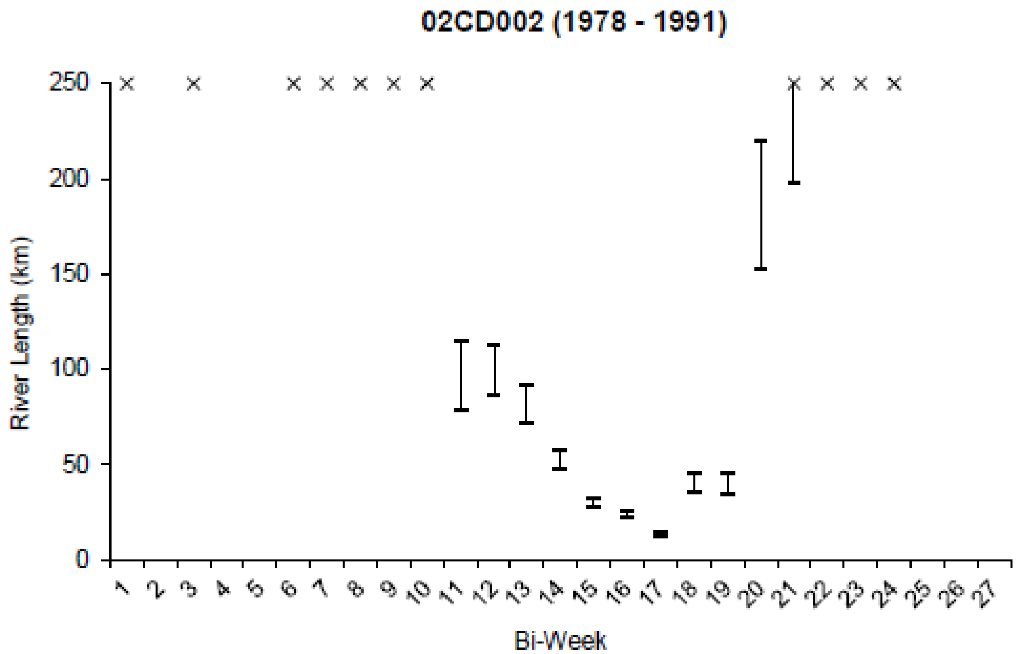


Figure A1-25 Gauging station 02CD001 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



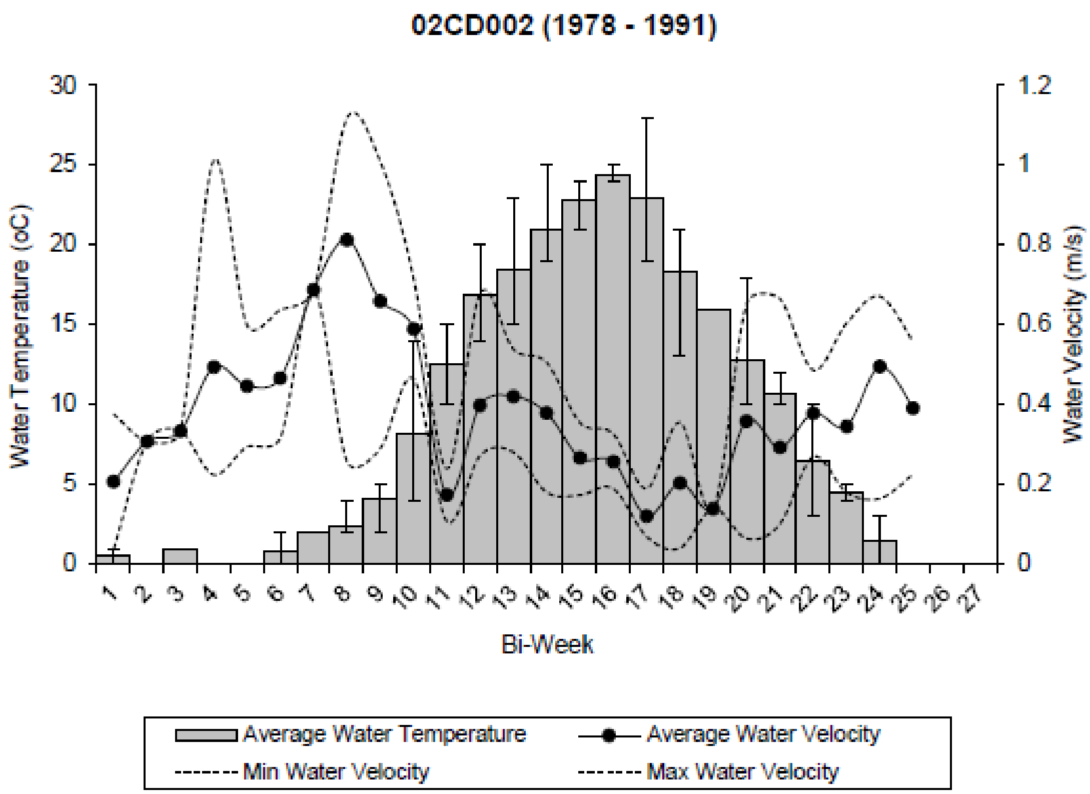


Figure A1-26. Gauging station 02CD002 data from 1978–1991. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

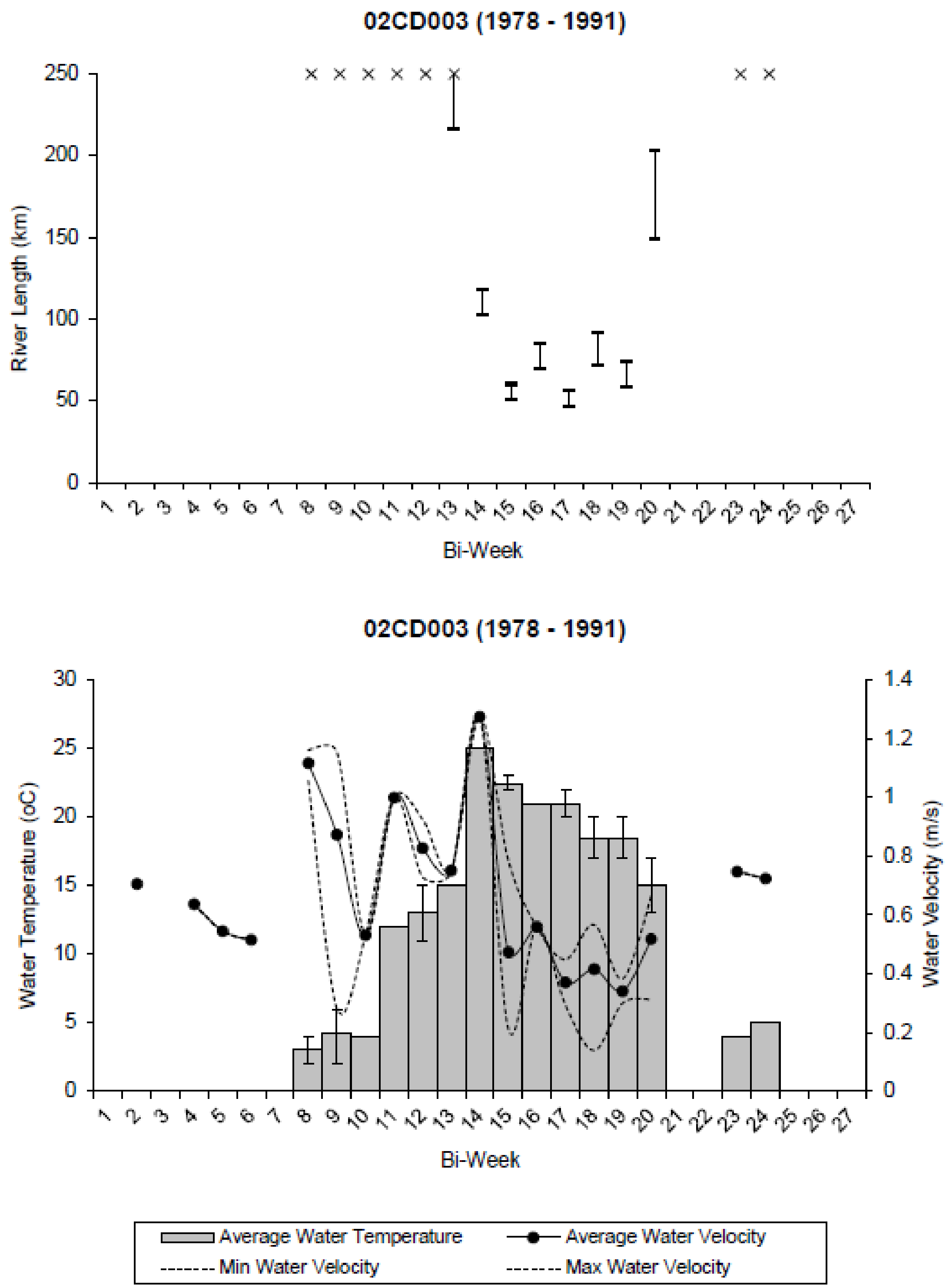
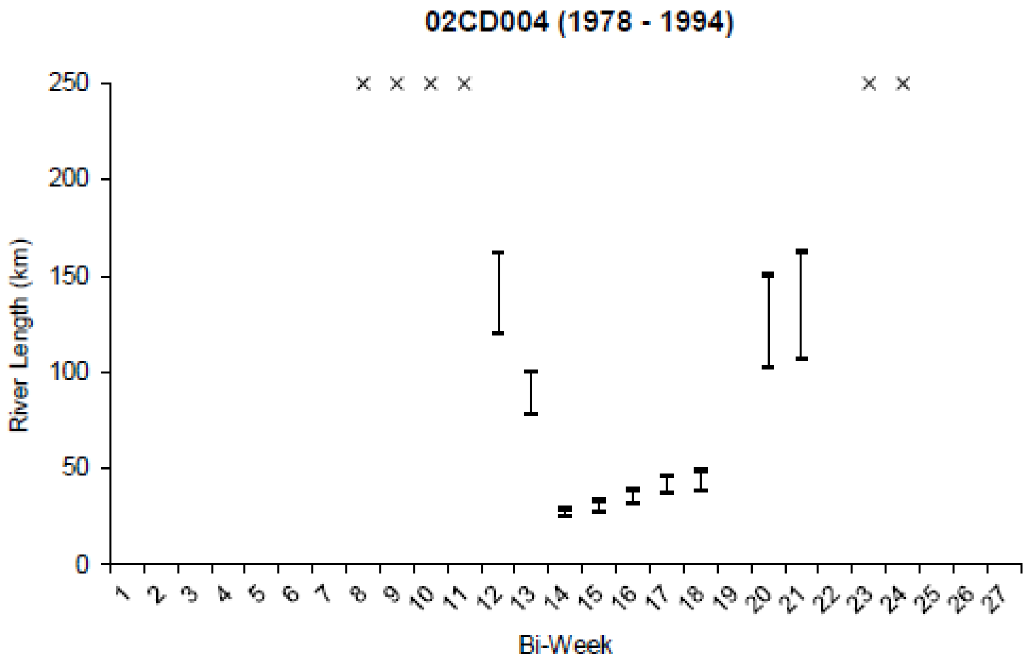


Figure A1-27 Gauging station 02CD003 data from 1978–1991. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



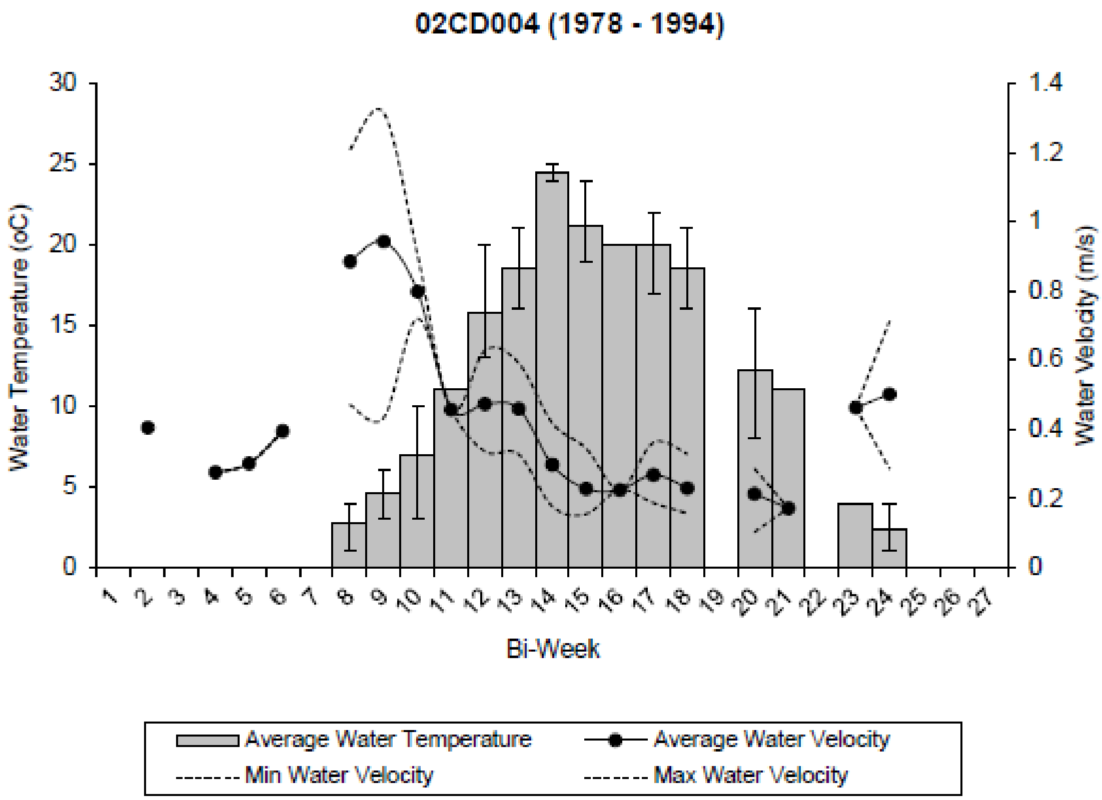


Figure A1-28. Gauging station 02CD004 data from 1978–1994. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

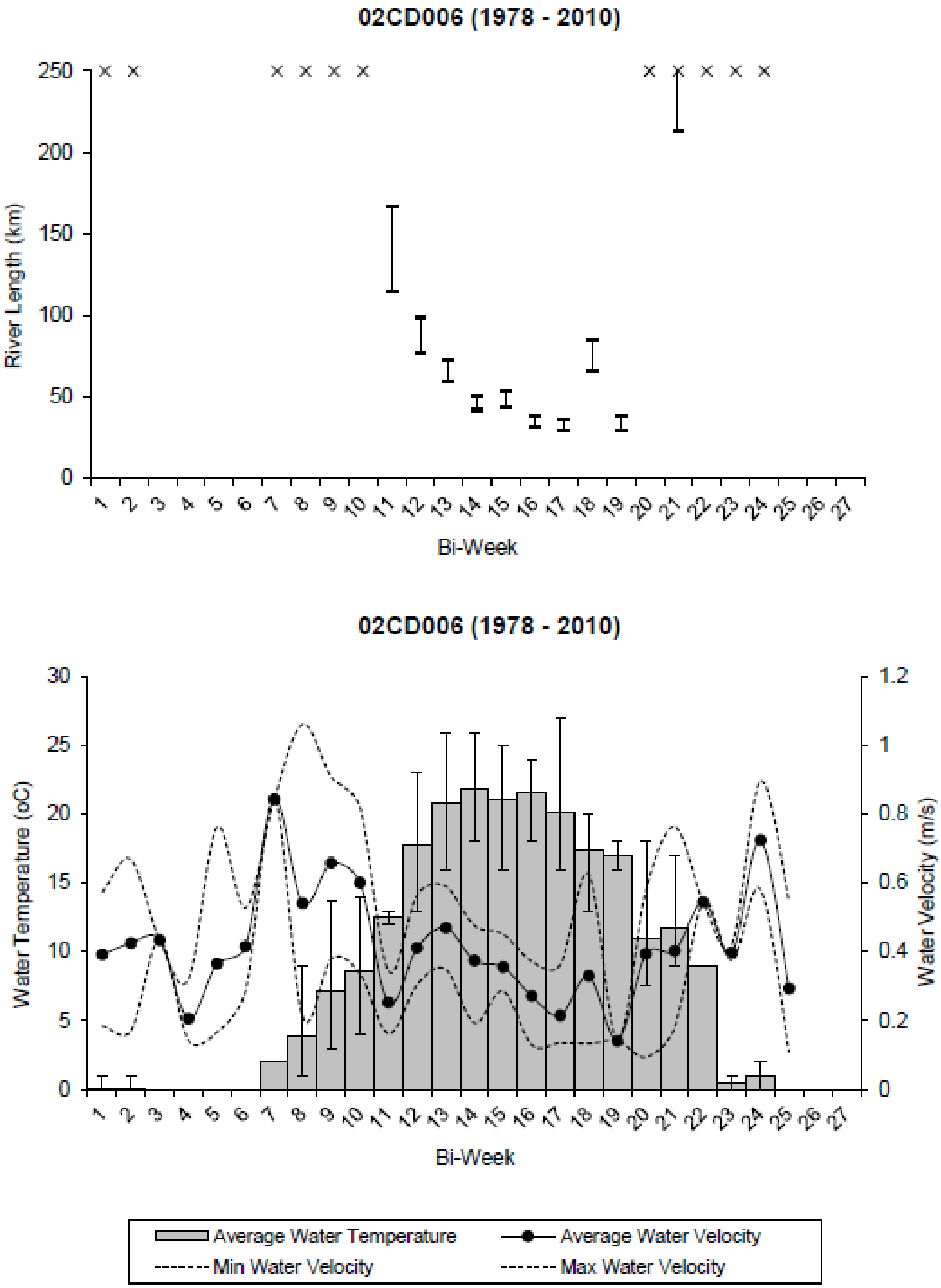
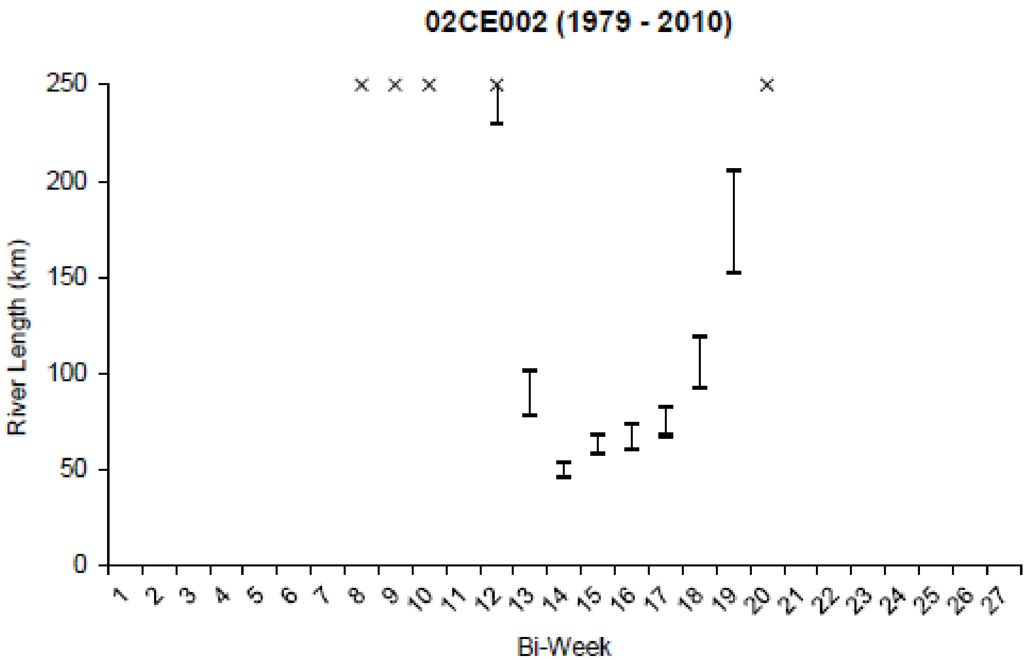


Figure A1-29. Gauging station 02CD006 data from 1978–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



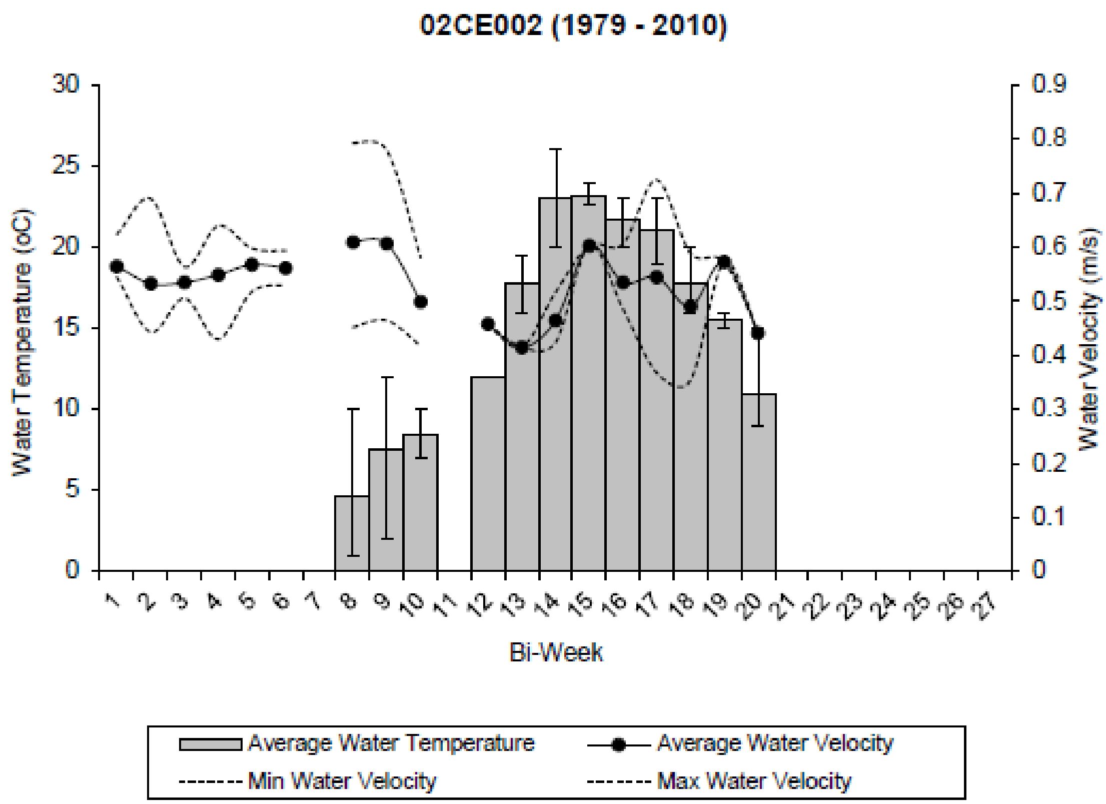


Figure A1-30. Gauging station 02CE002 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

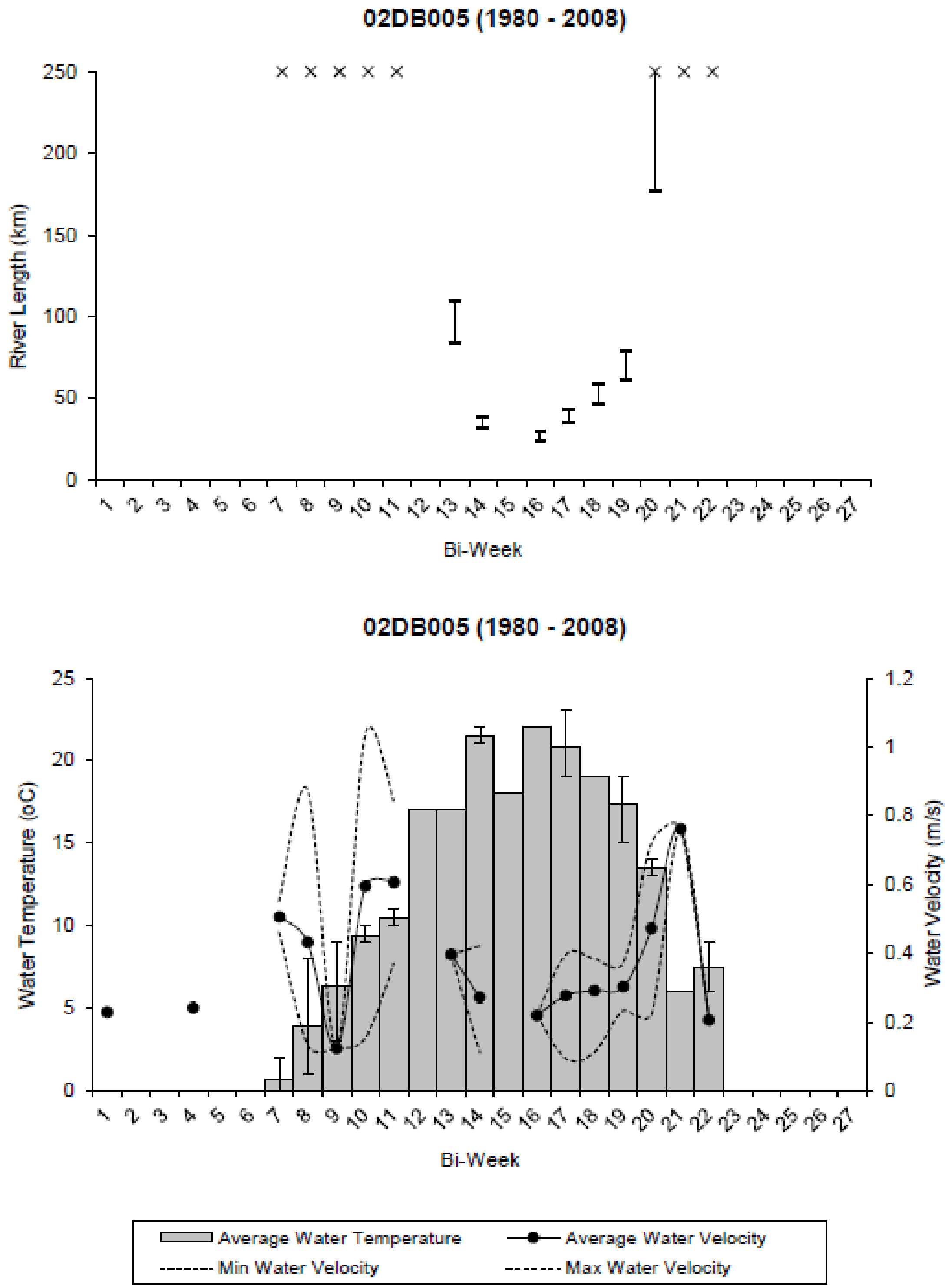
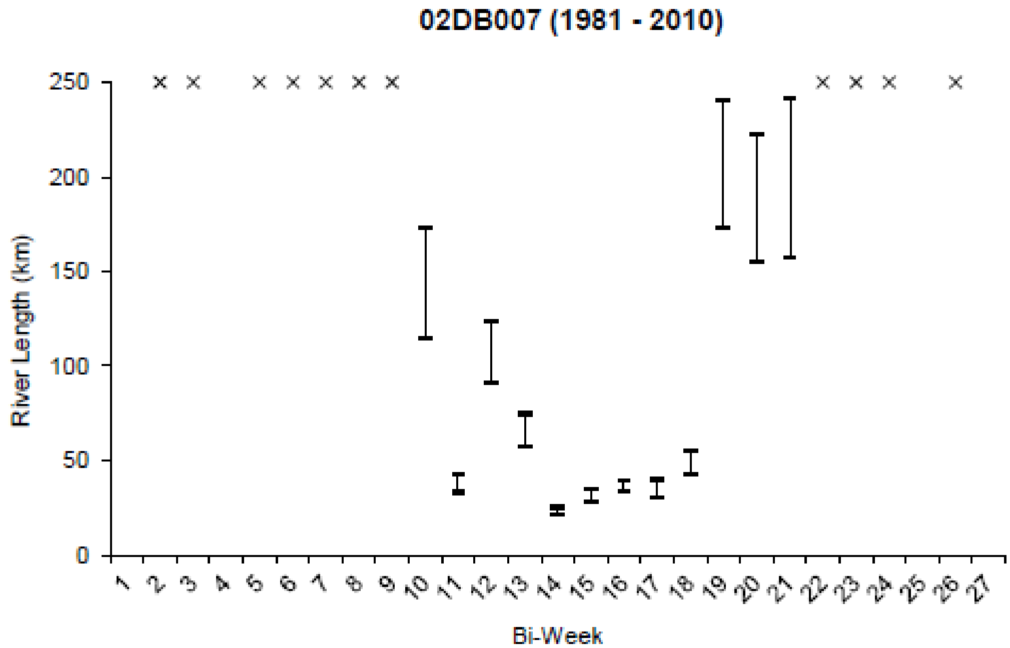


Figure A1-31. Gauging station 02DB005 data from 1980–2008. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



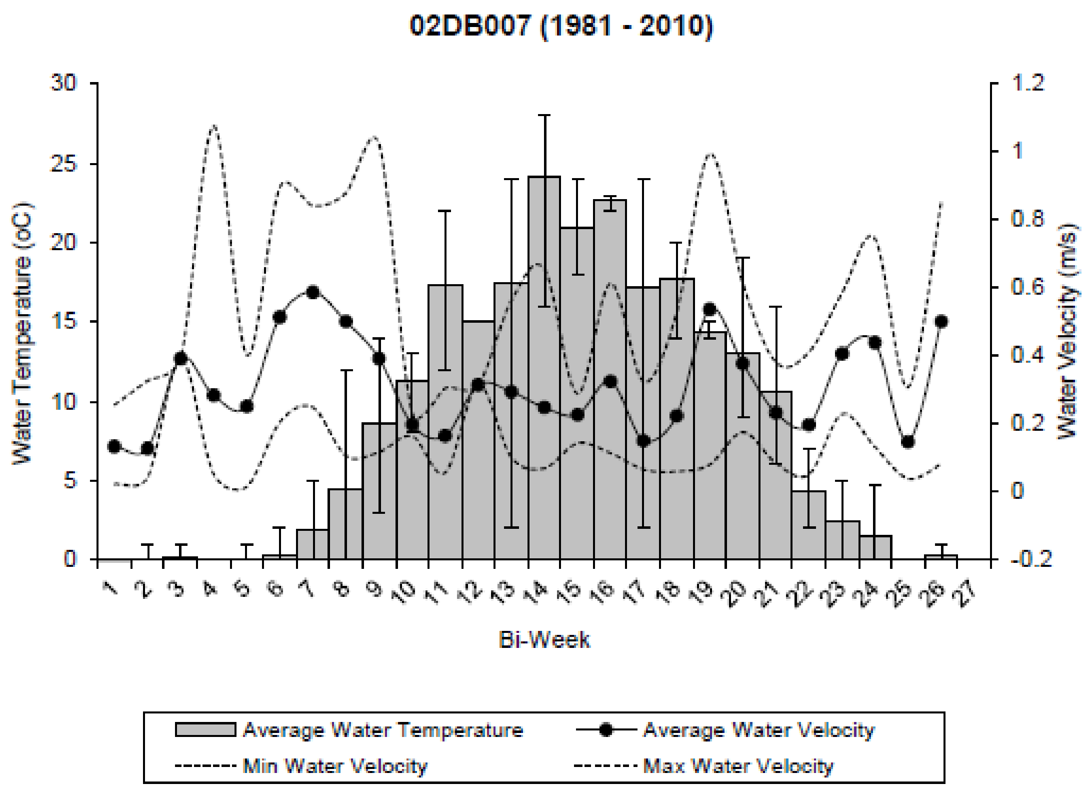
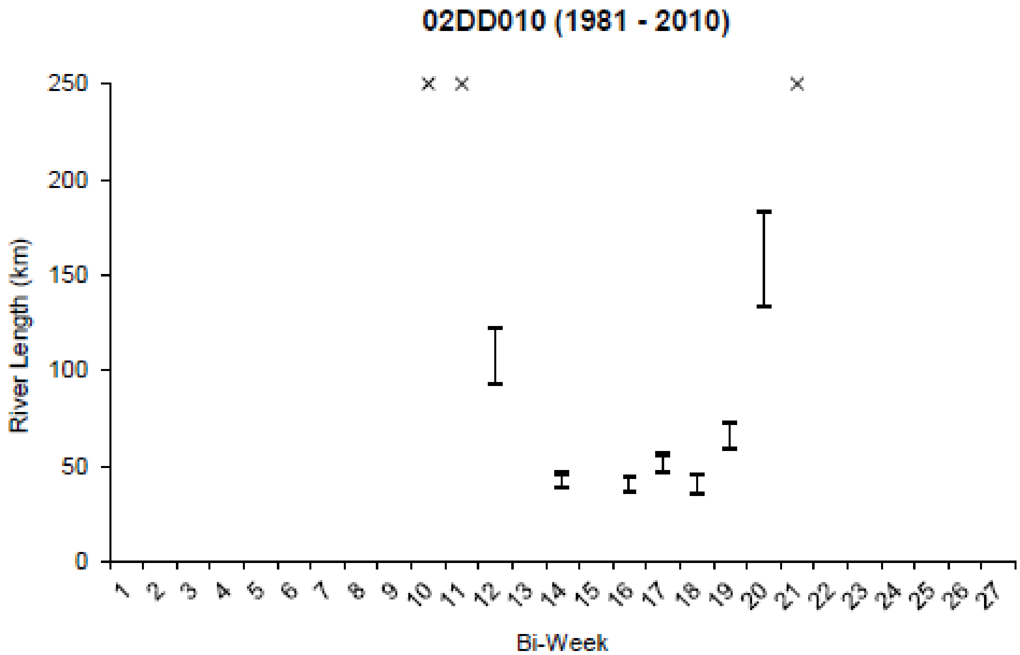


Figure A1-32. Gauging station 02DB007 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



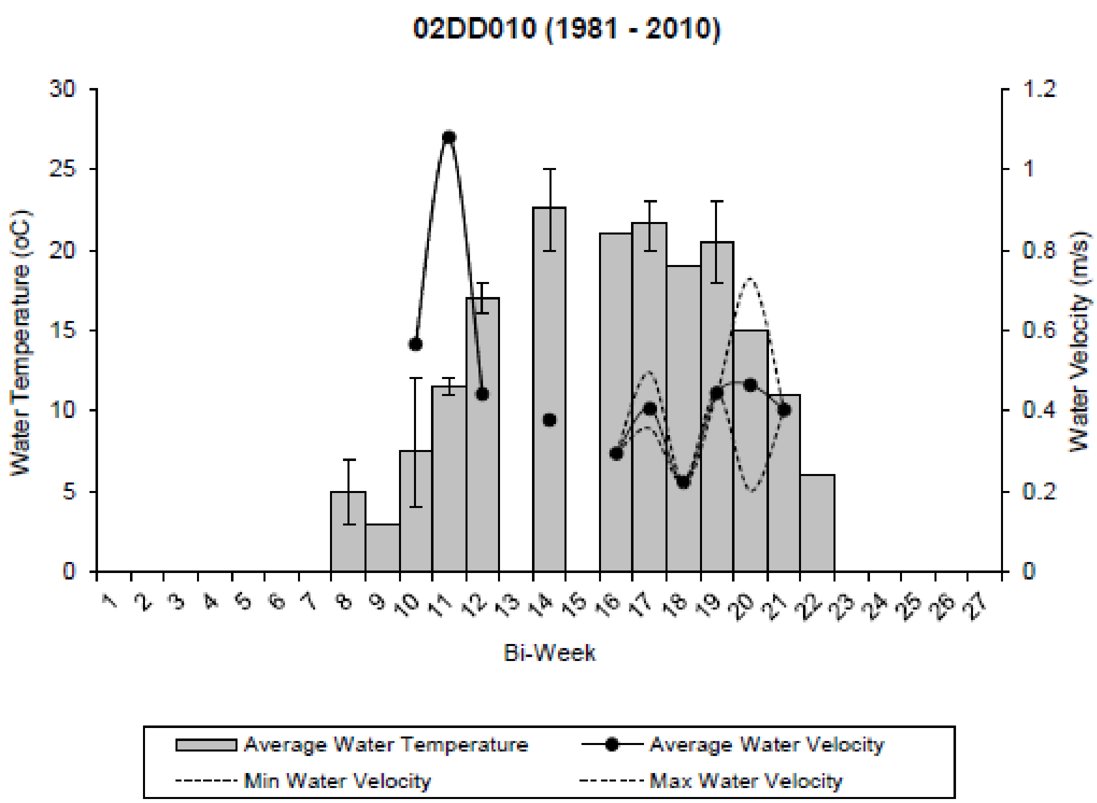
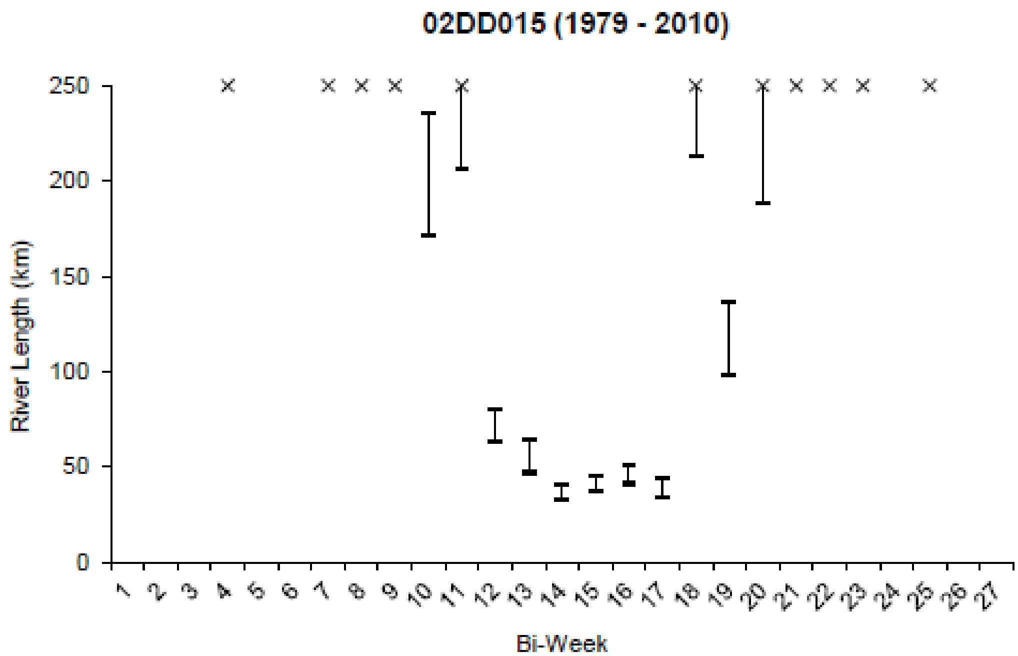


Figure A1-33. Gauging station 02DD010 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



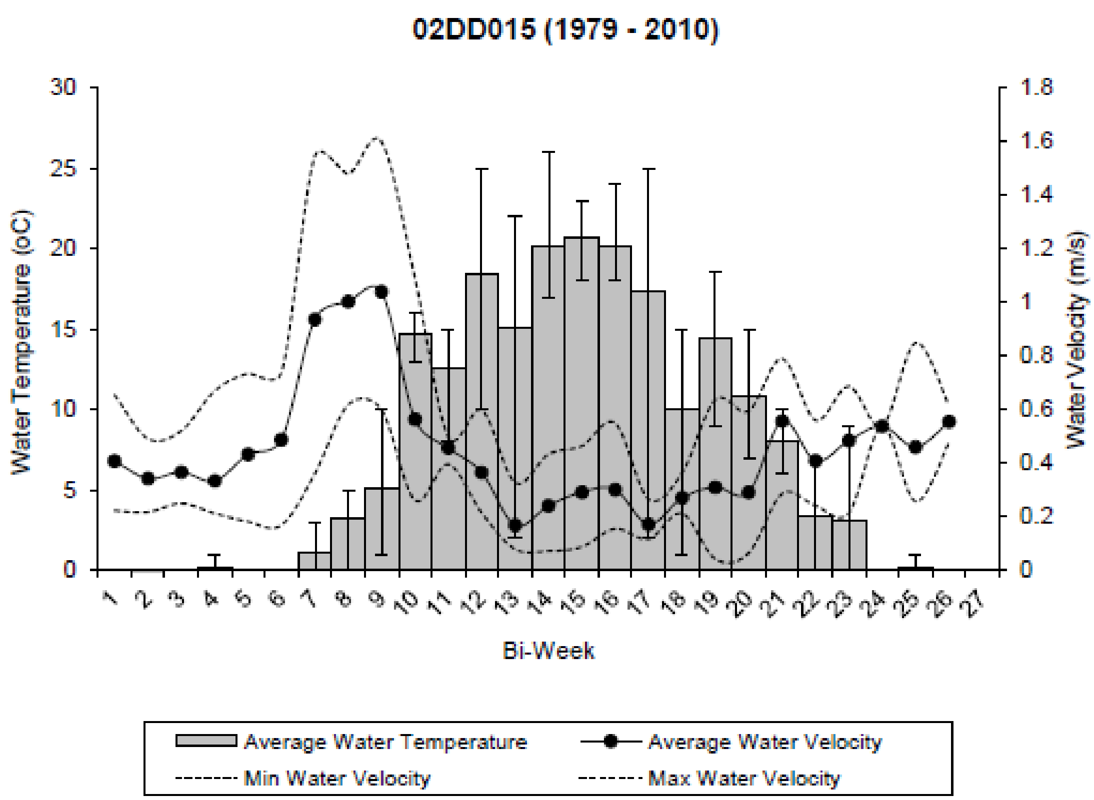
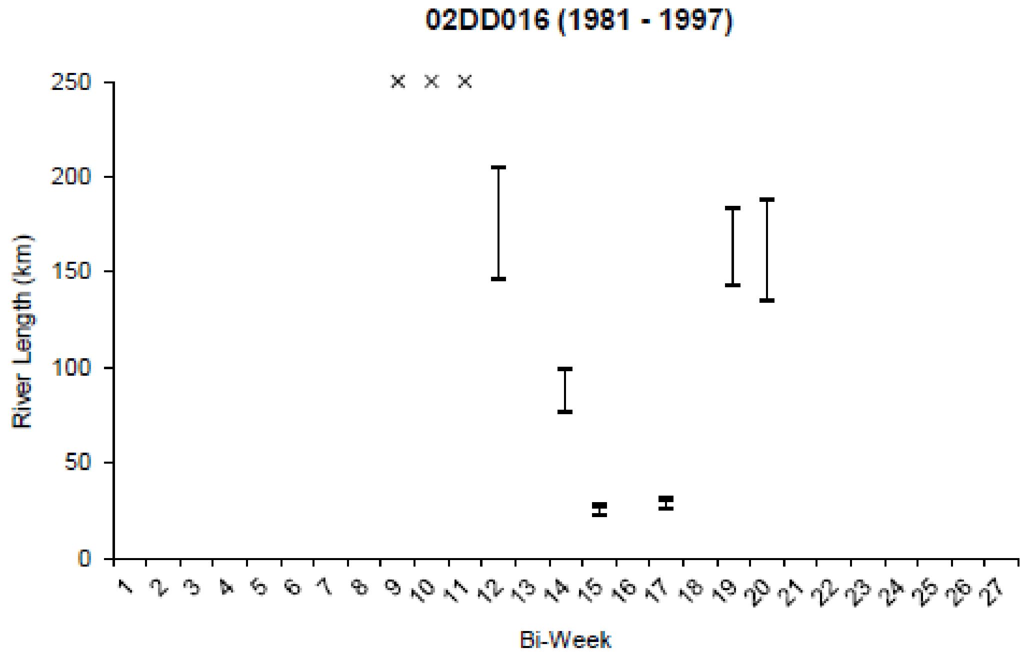


Figure A1-34. Gauging station 02DD015 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



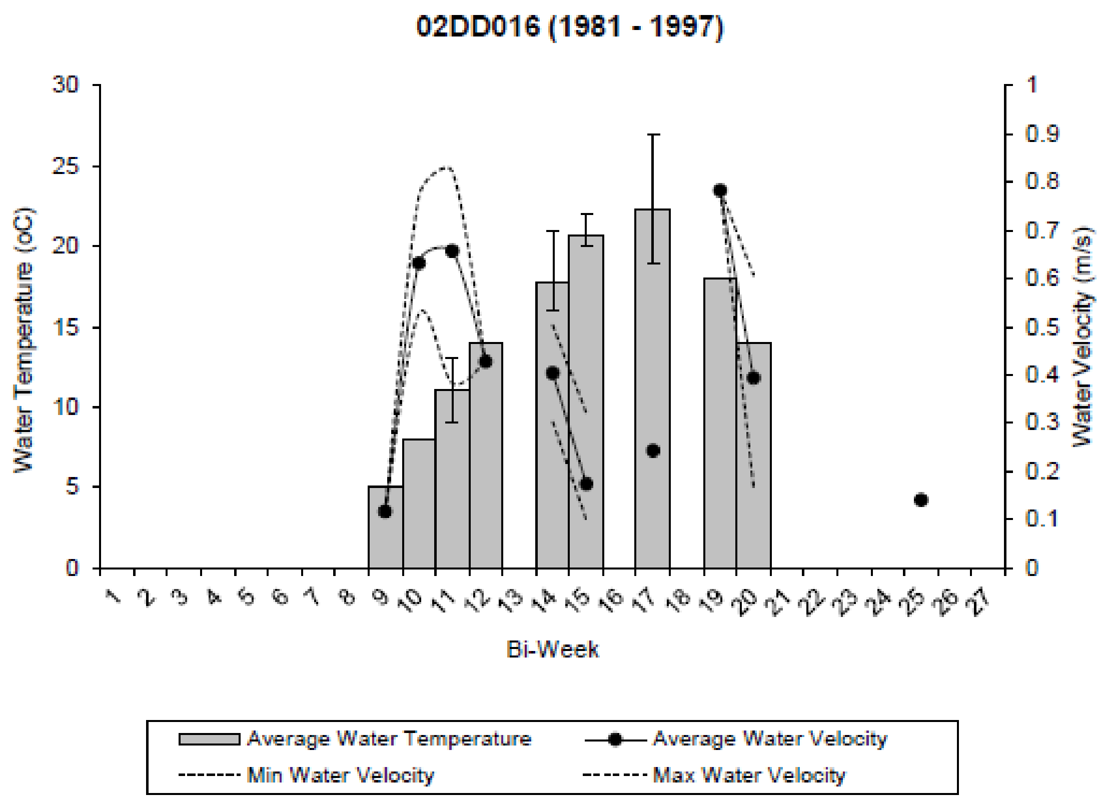


Figure A1-35. Gauging station 02DD016 data from 1981–1997. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

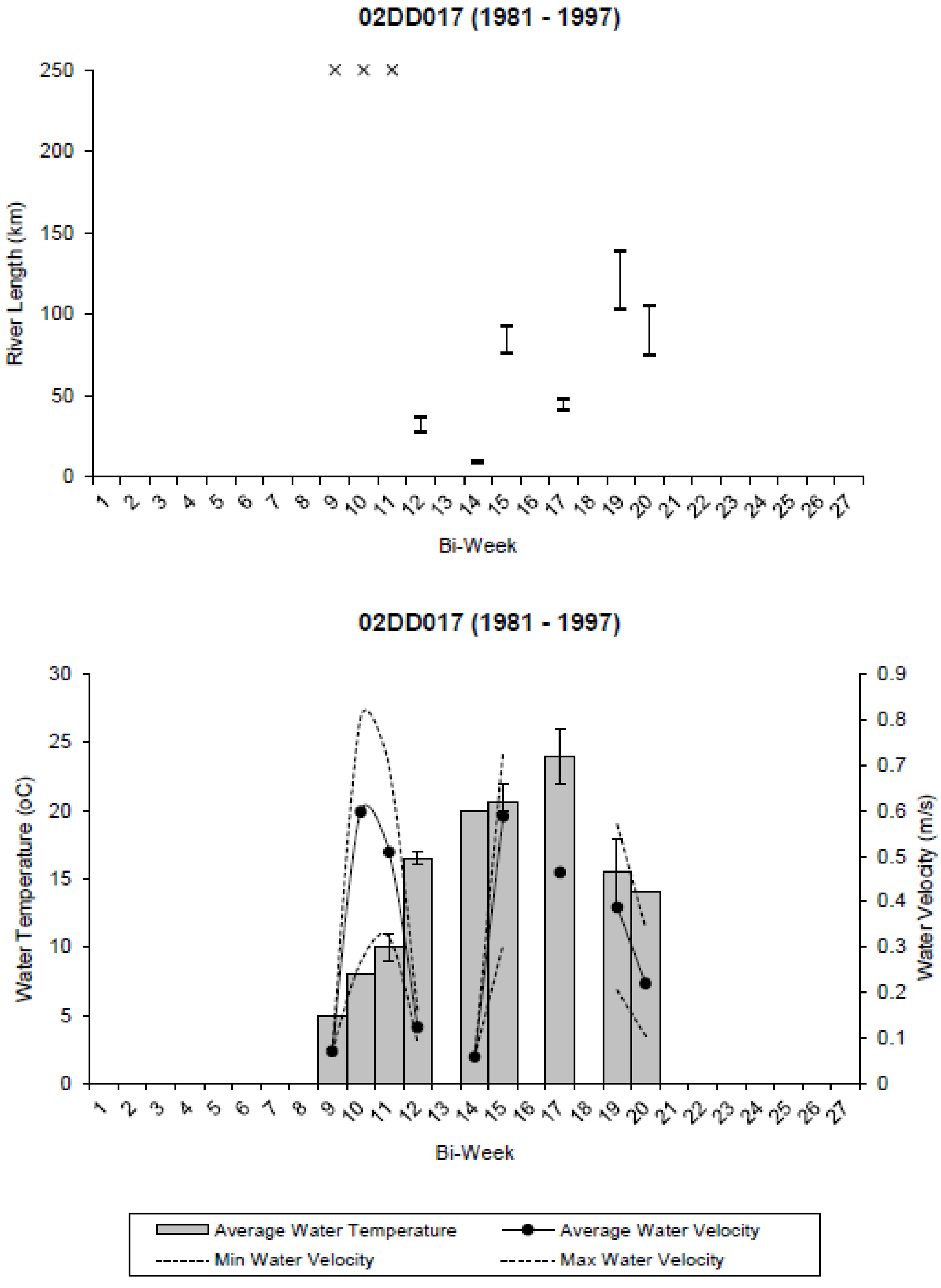
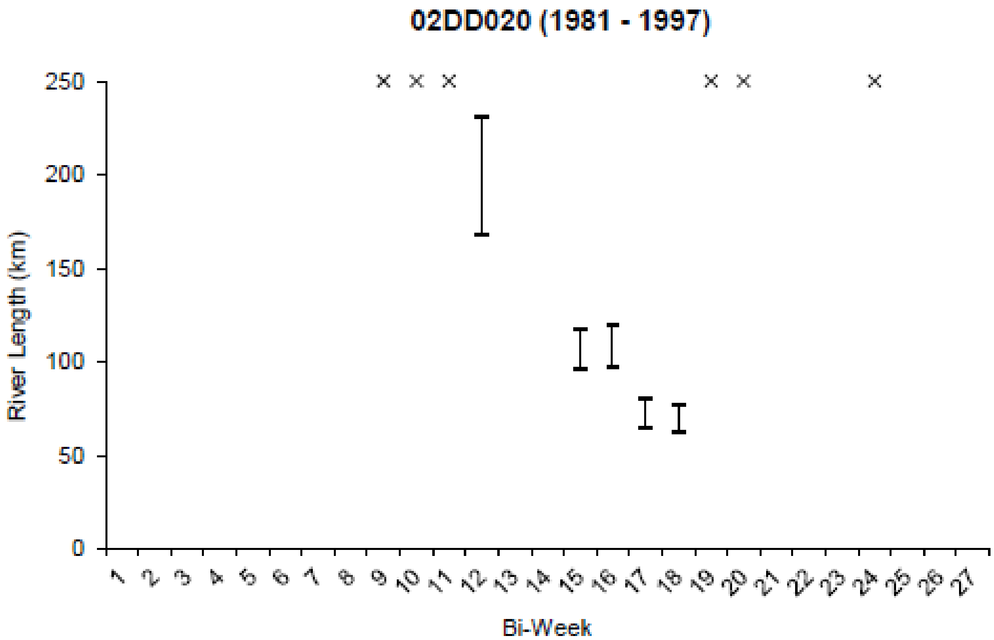


Figure A1-36. Gauging station 02DD017 data from 1981–1997. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



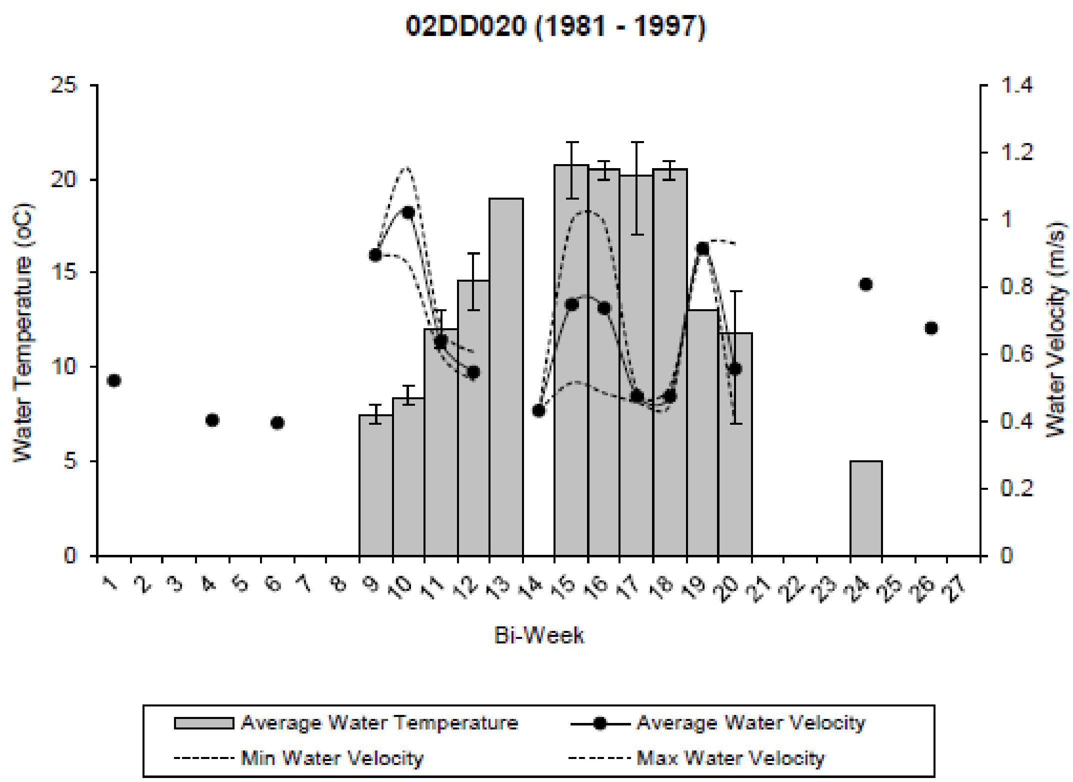


Figure A1-37. Gauging station 02DD020 data from 1981–1997. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

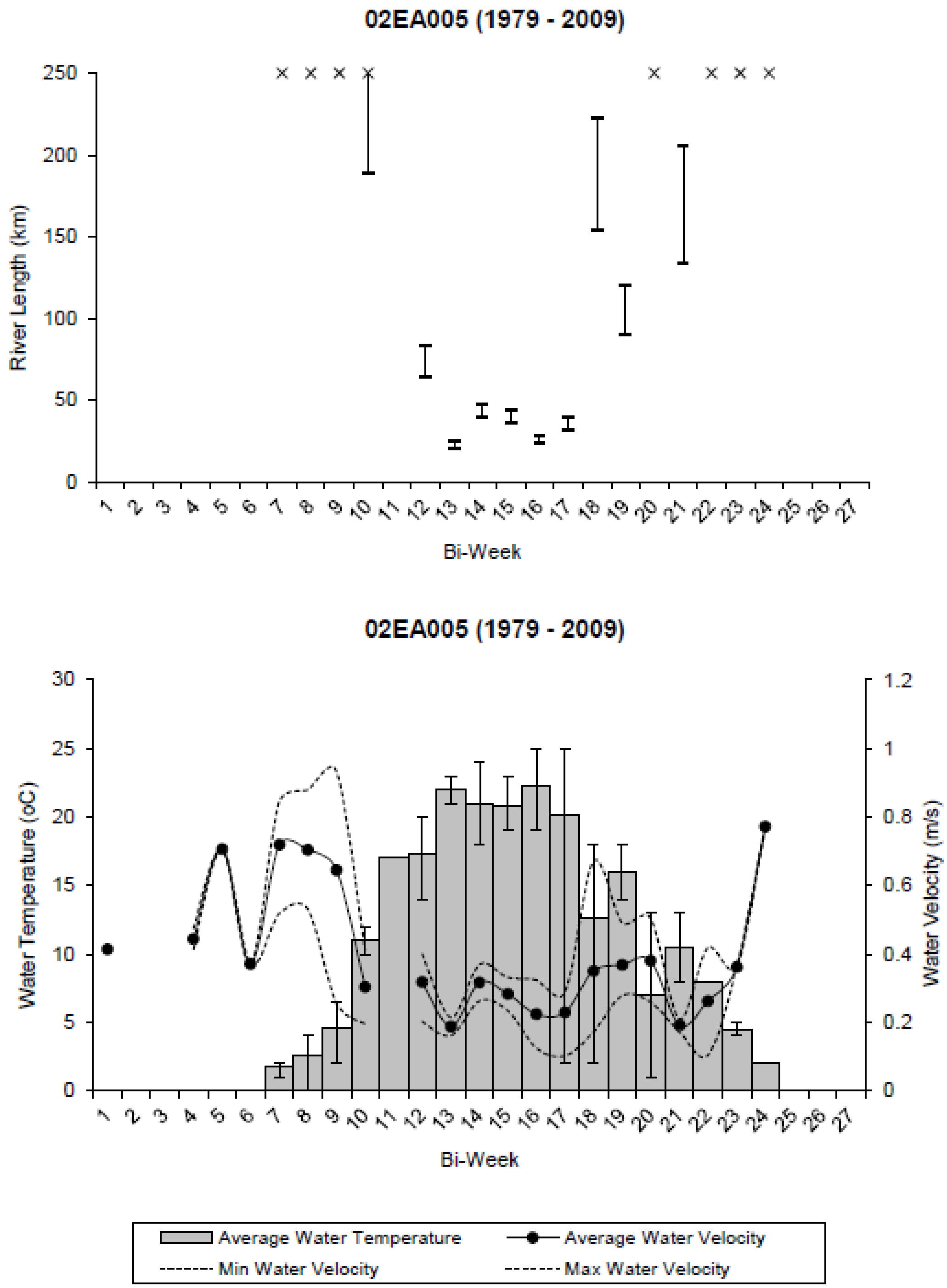
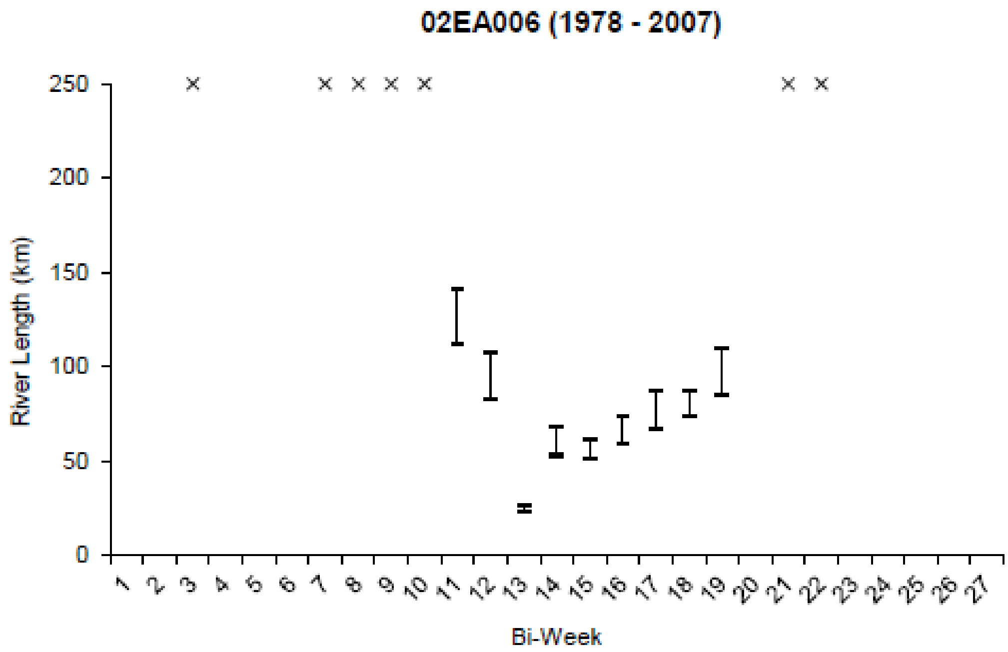


Figure A1-38. Gauging station 02EA005 data from 1979–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



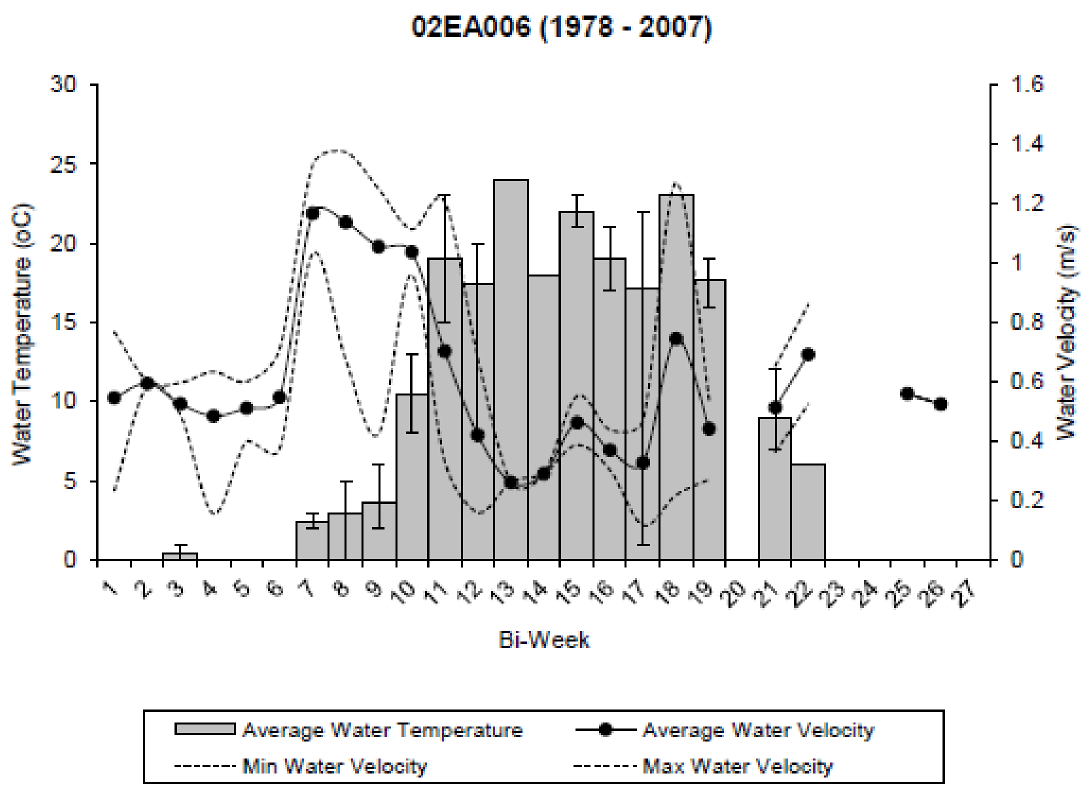
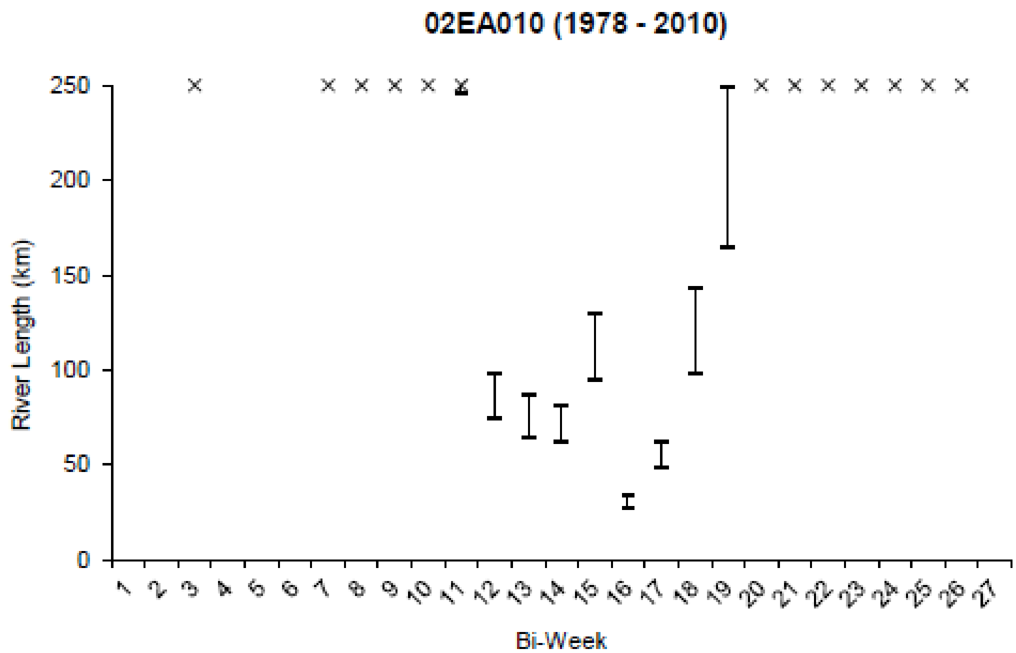


Figure A1-39. Gauging station 02EA006 data from 1978–2007. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



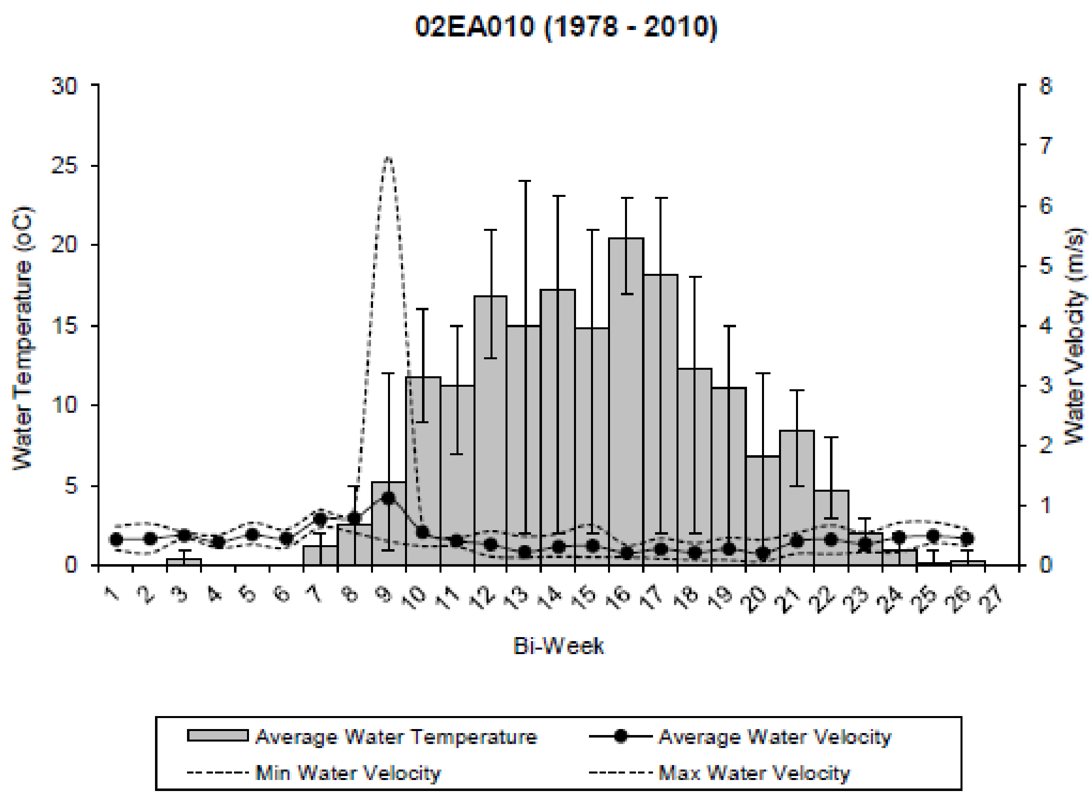
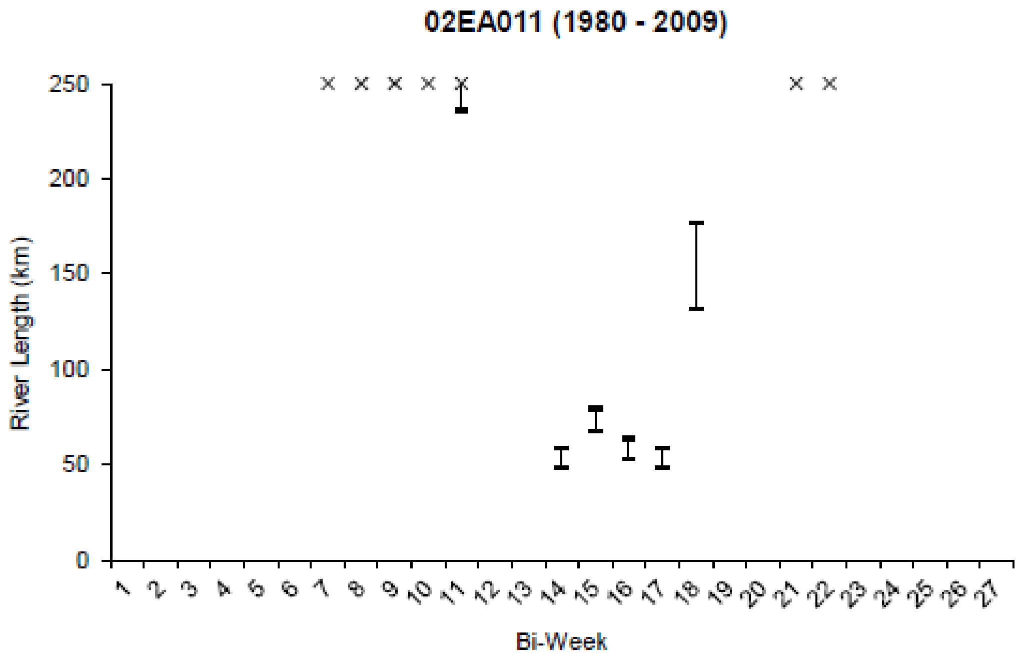


Figure A1-40. Gauging station 02EA010 data from 1978–2007. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



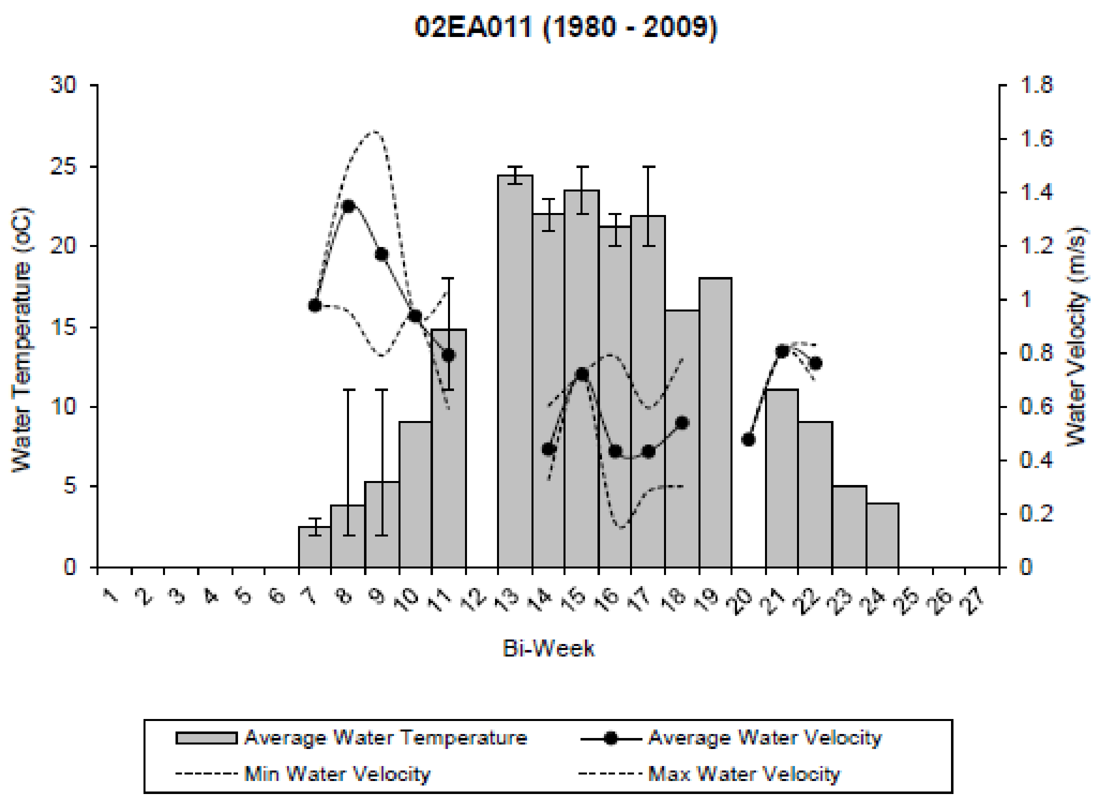
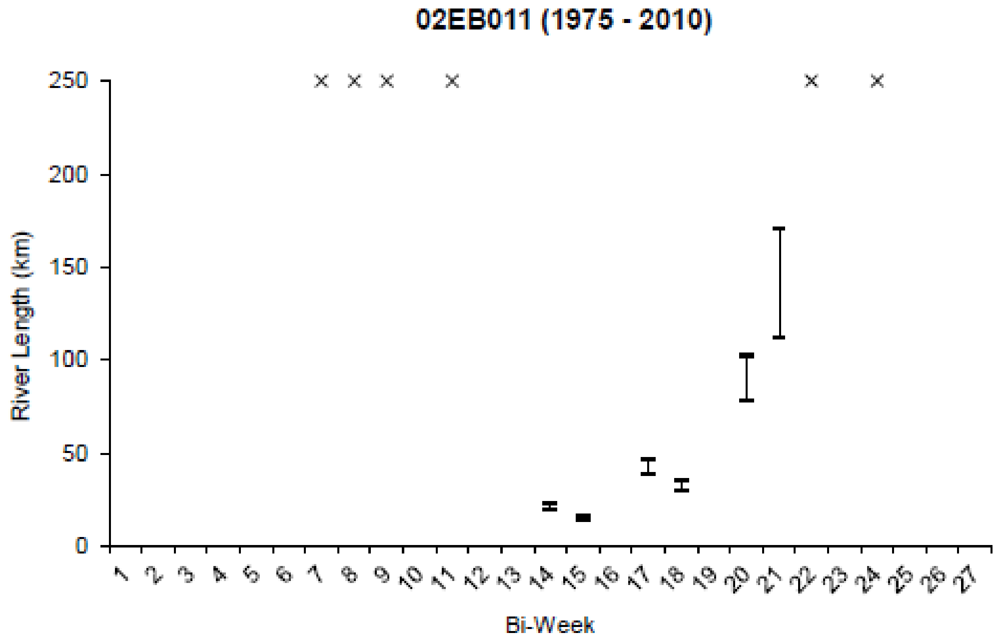


Figure A1-41. Gauging station 02EA011 data from 1980–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



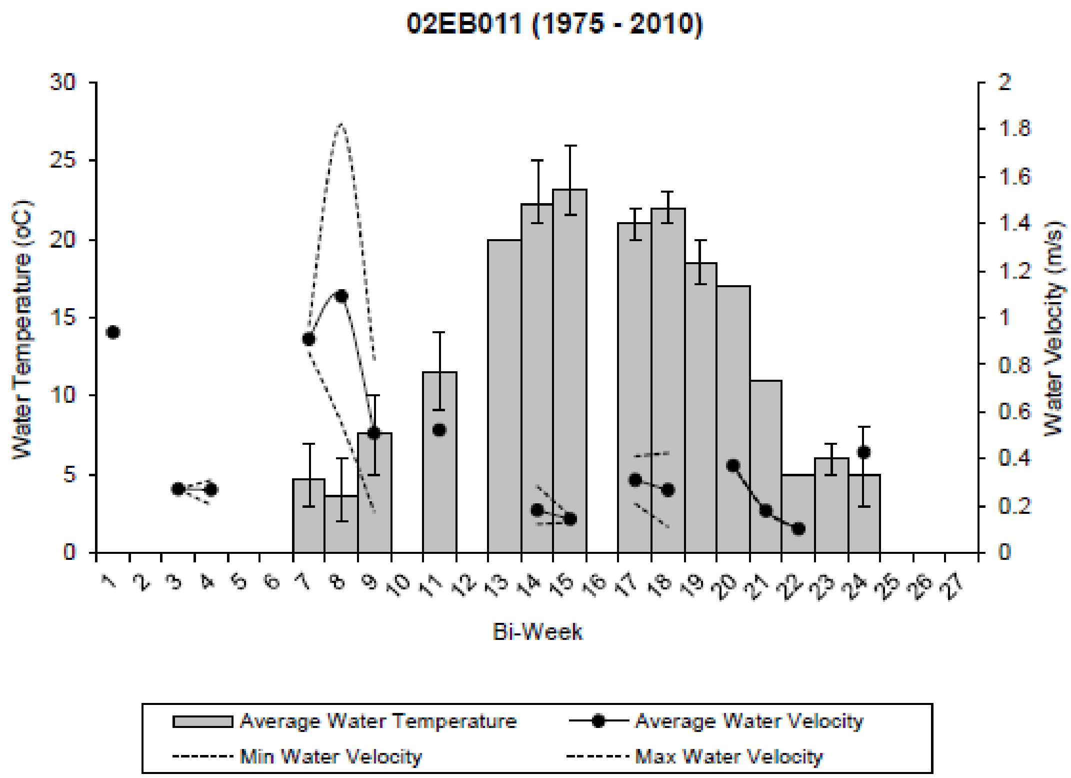


Figure A1-42. Gauging station 02EB011 data from 1975–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

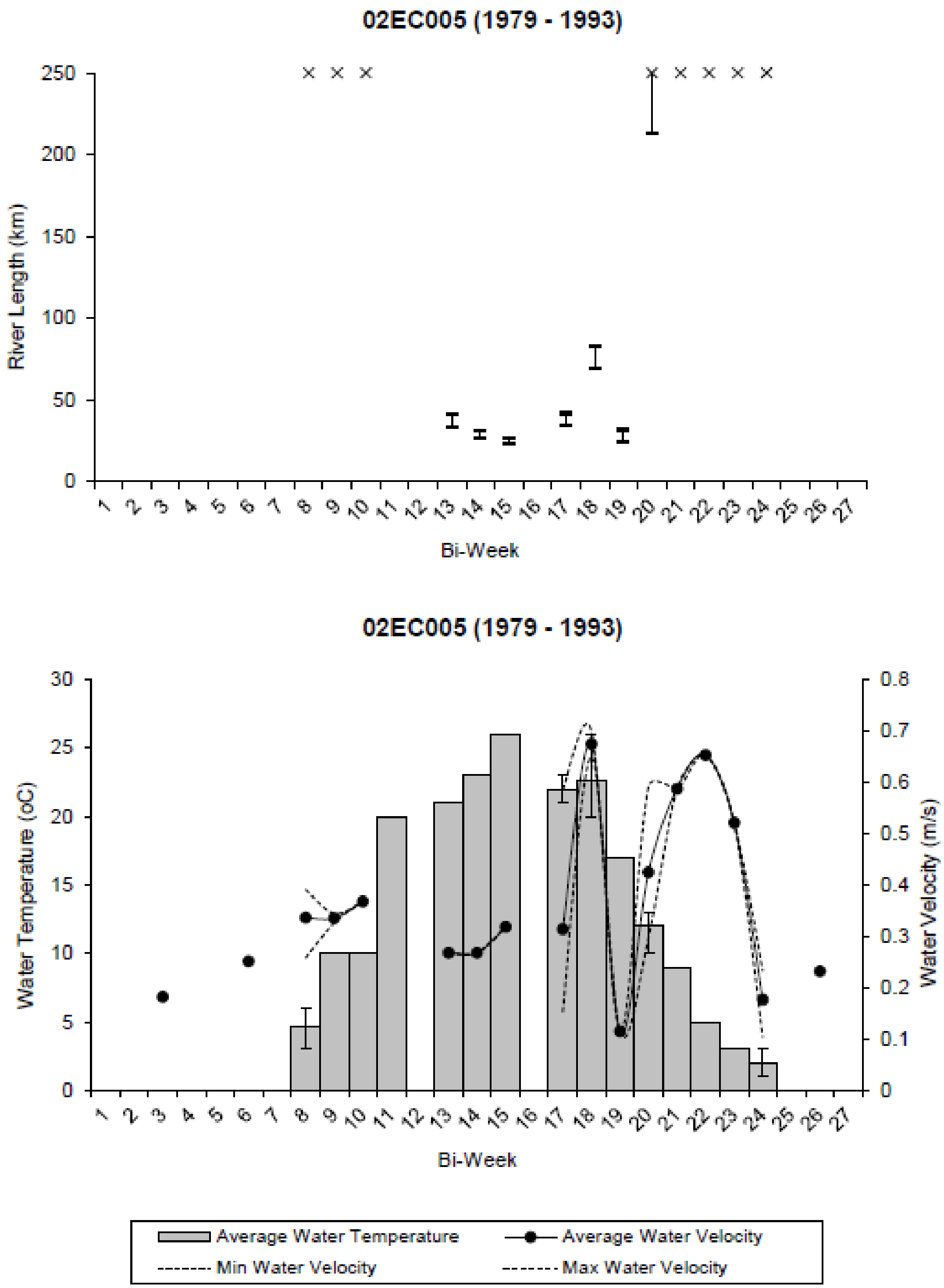
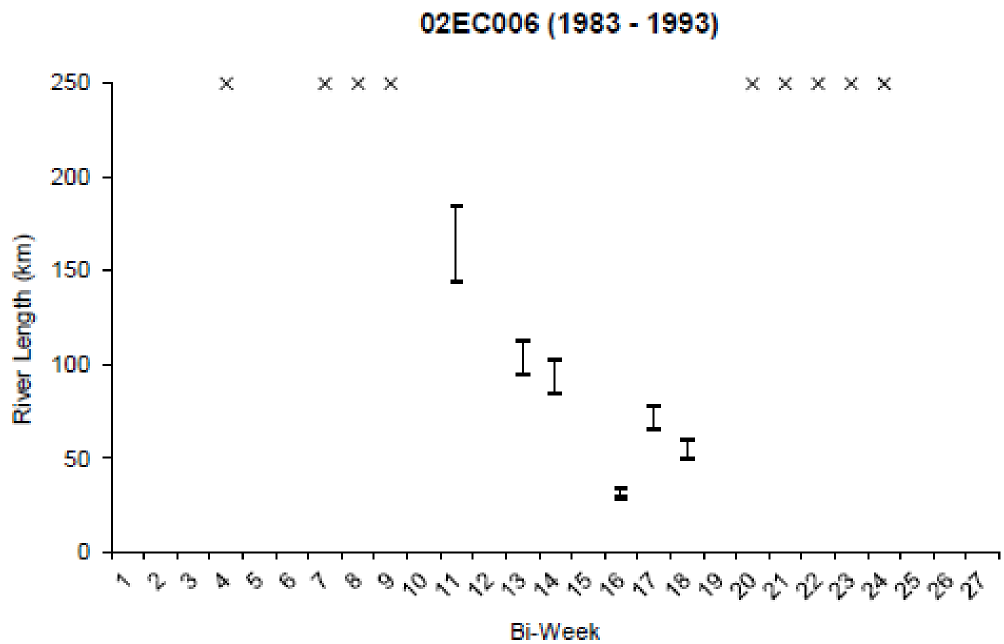


Figure A1-43. Gauging station 02EC005 data from 1979–1993. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



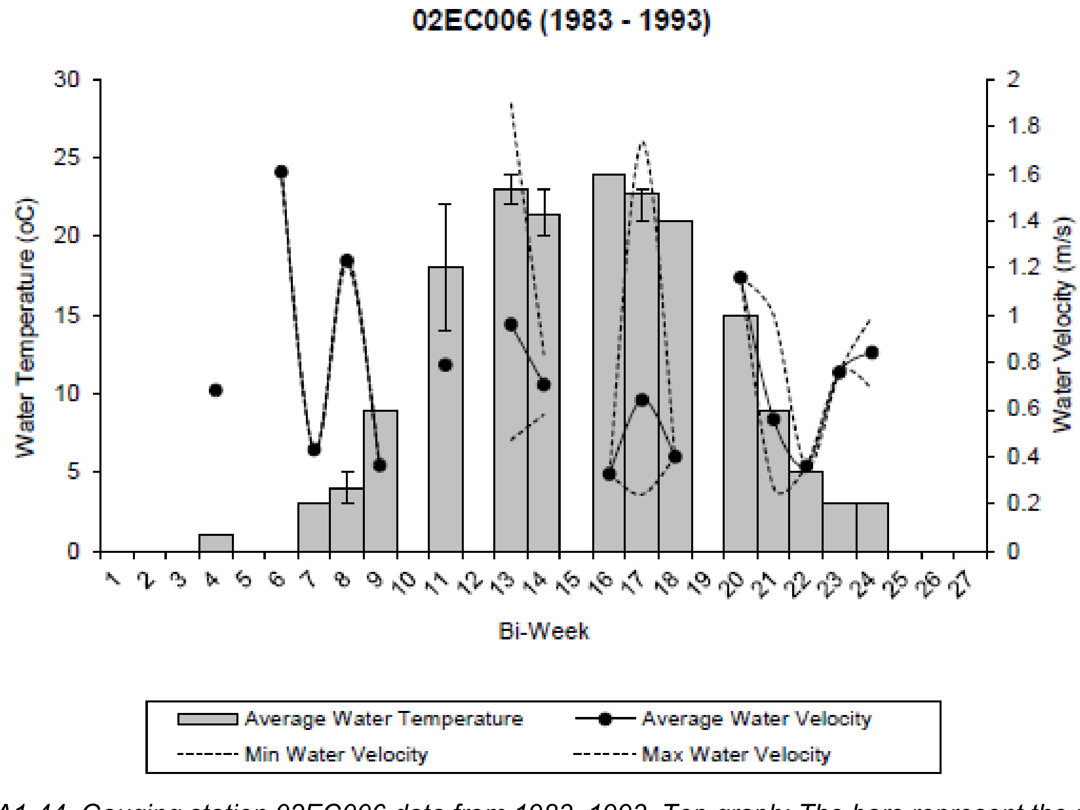
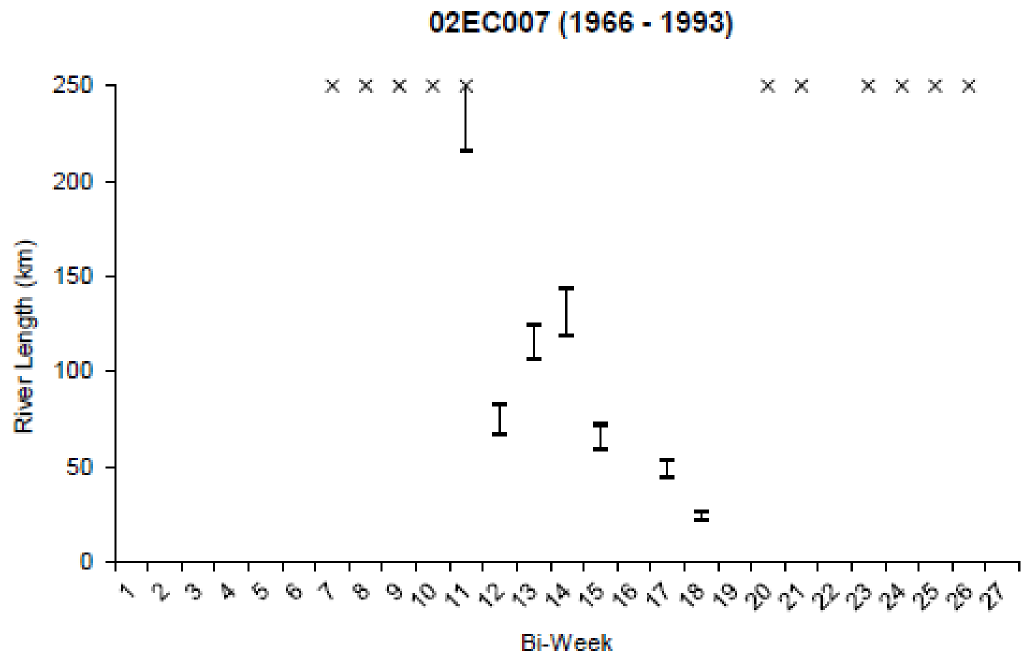


Figure A1-44. Gauging station 02EC006 data from 1983–1993. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



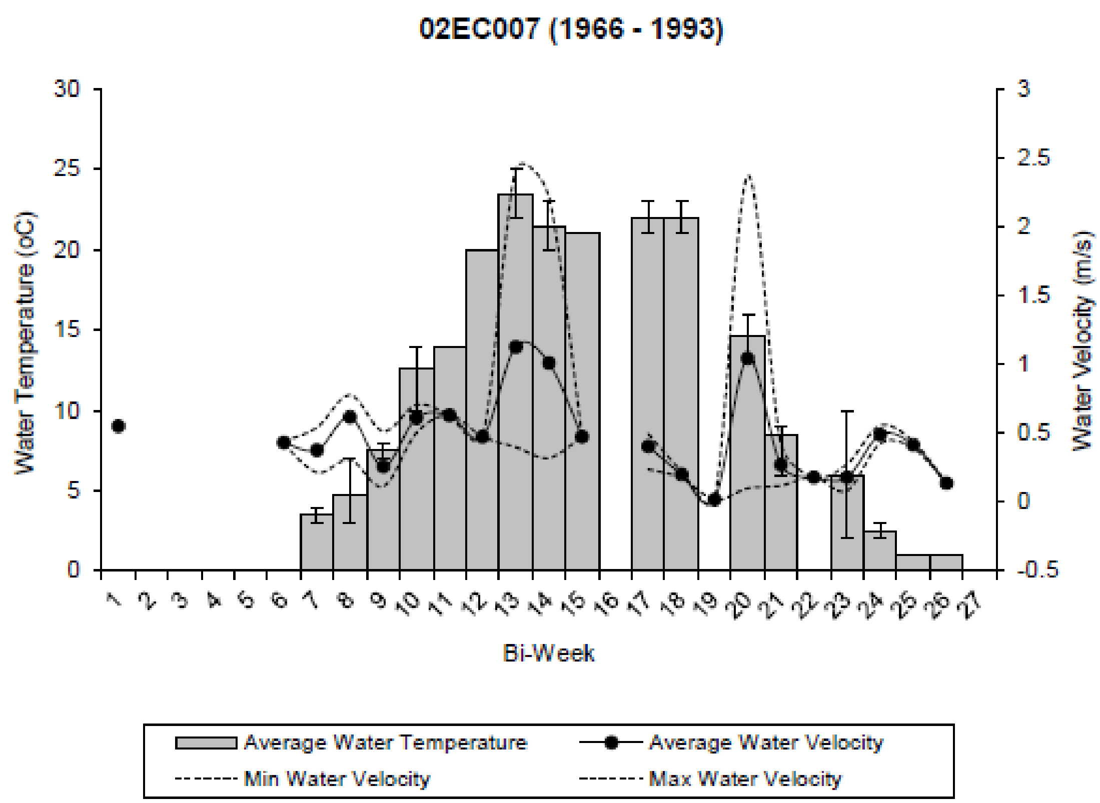
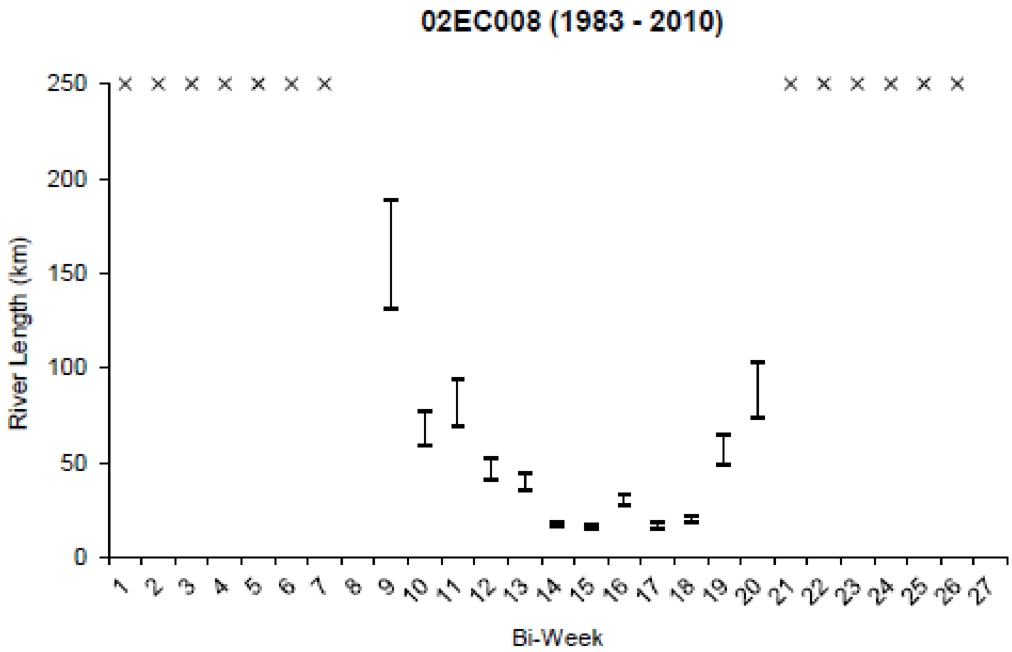


Figure A1-45. Gauging station 02EC007 data from 1966–1993. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



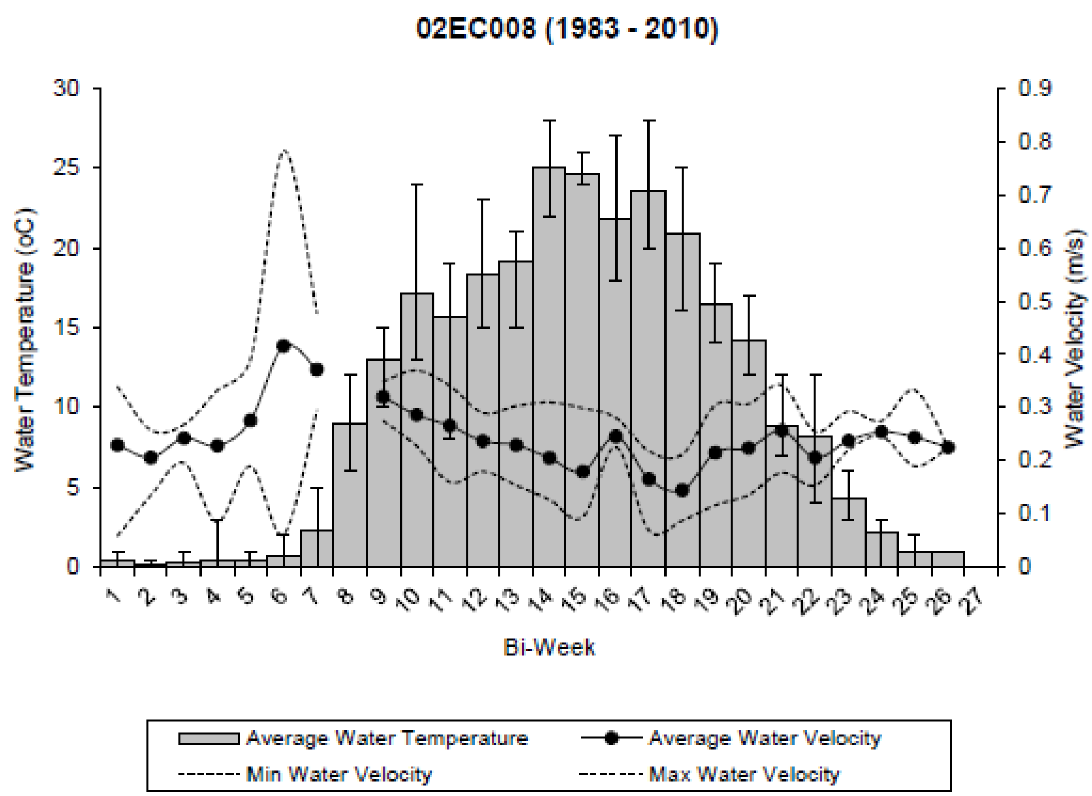
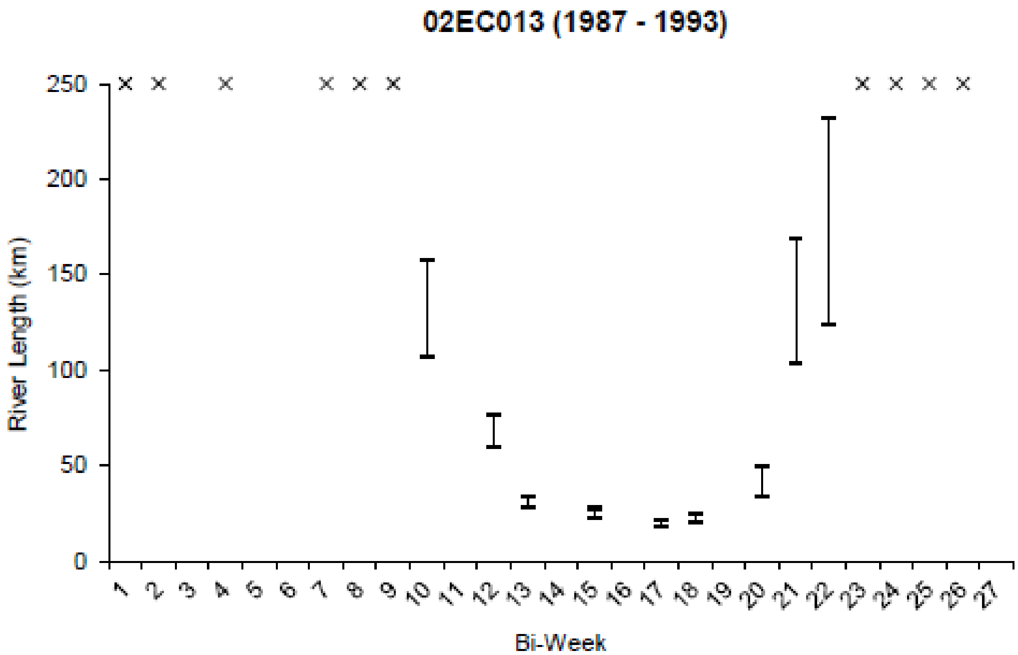


Figure A1-46. Gauging station 02EC008 data from 1983–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



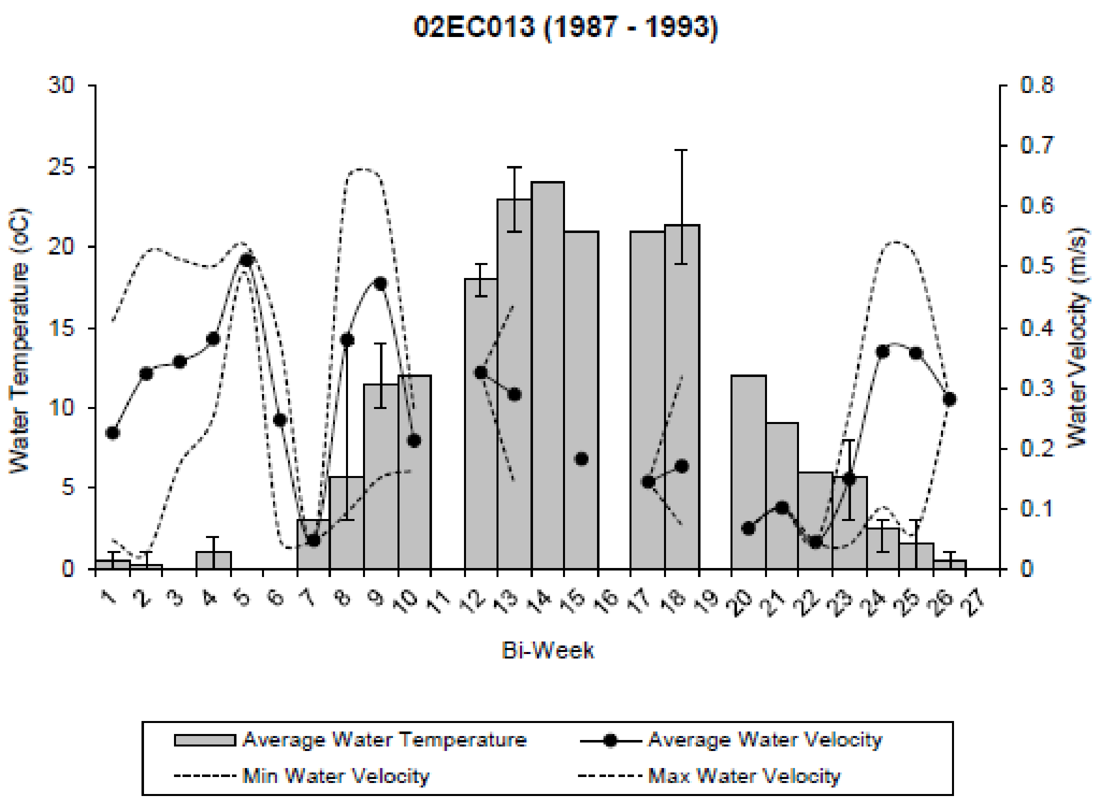
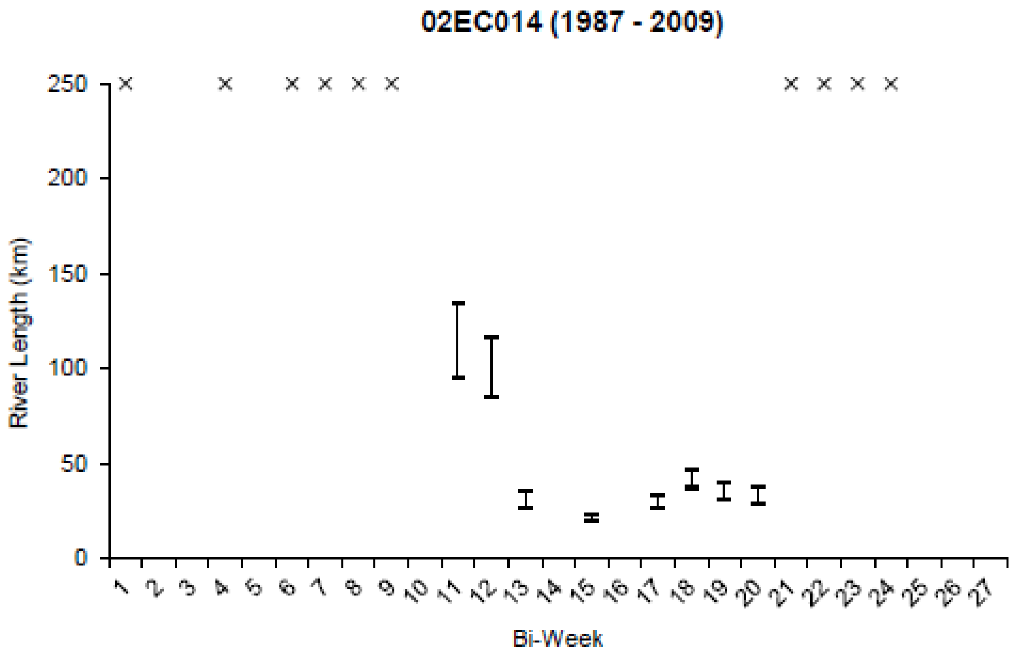


Figure A1-47. Gauging station 02EC013 data from 1987–1993. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



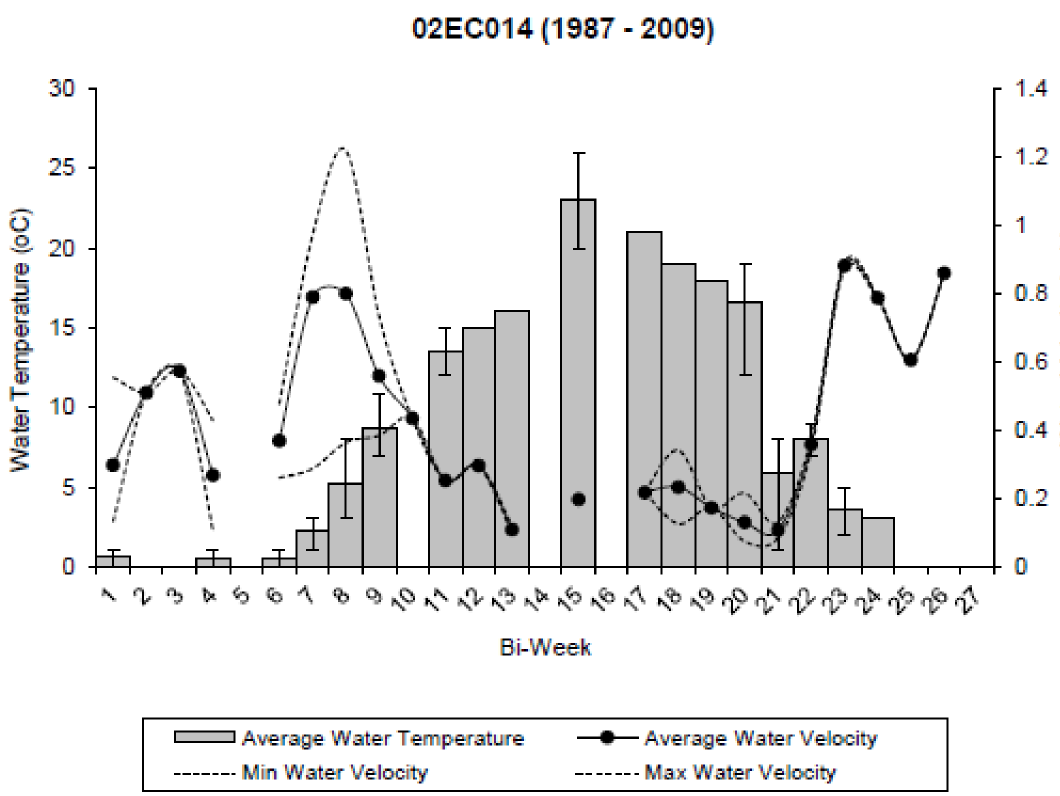


Figure A1-48. Gauging station 02EC014 data from 1987–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

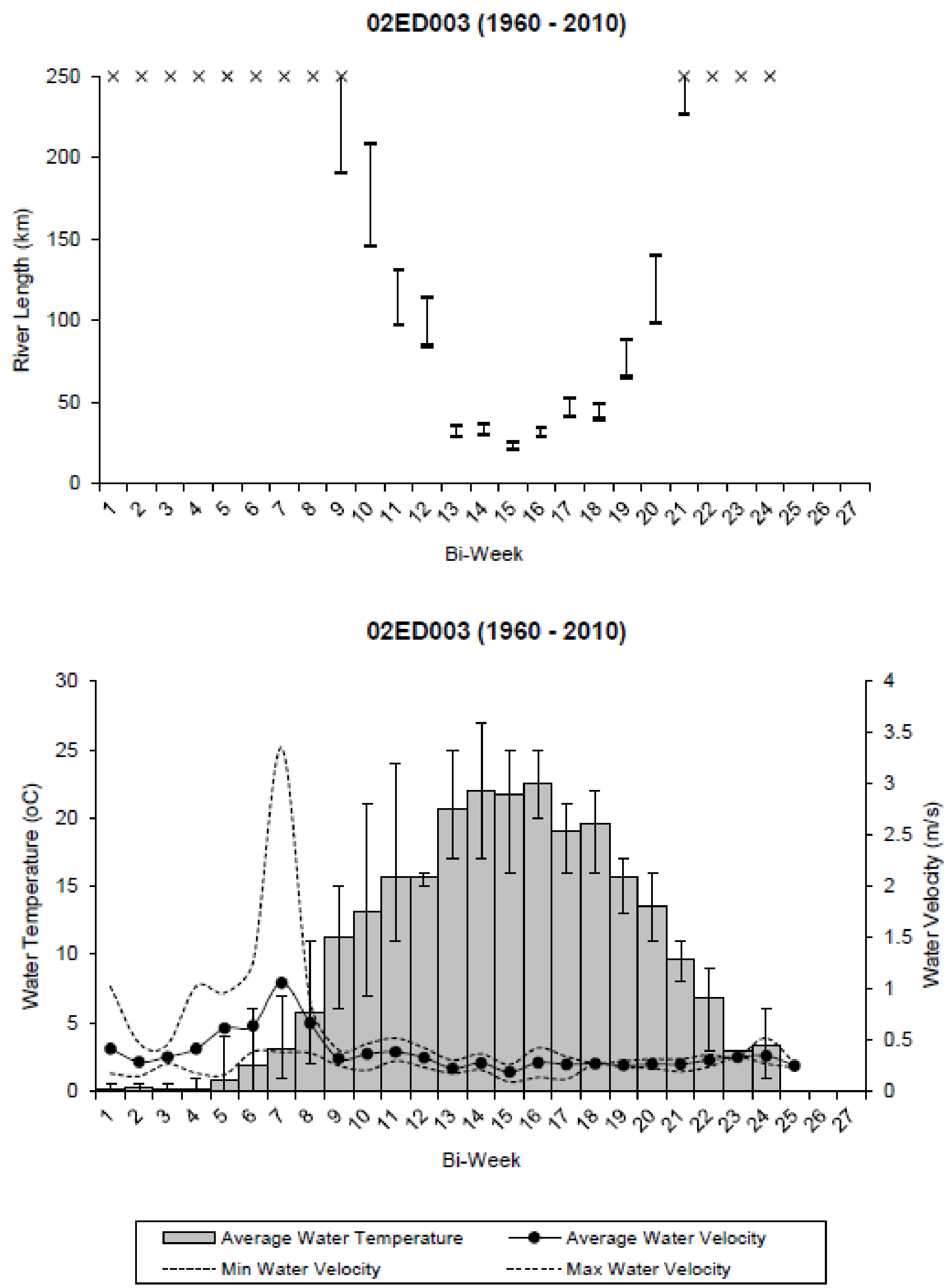
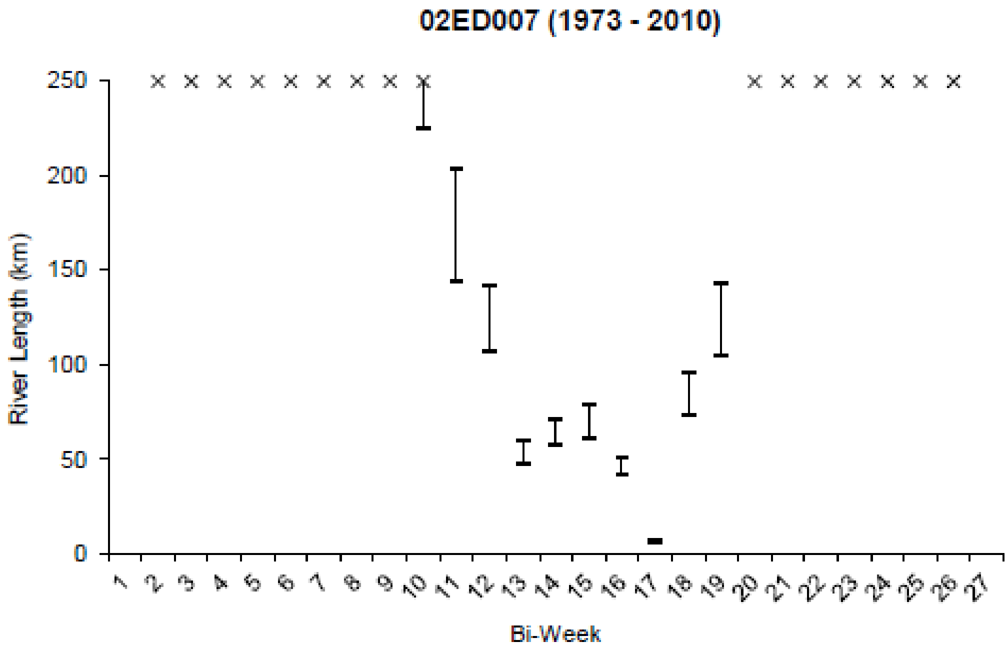


Figure A1-49. Gauging station 02ED003 data from 1960–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



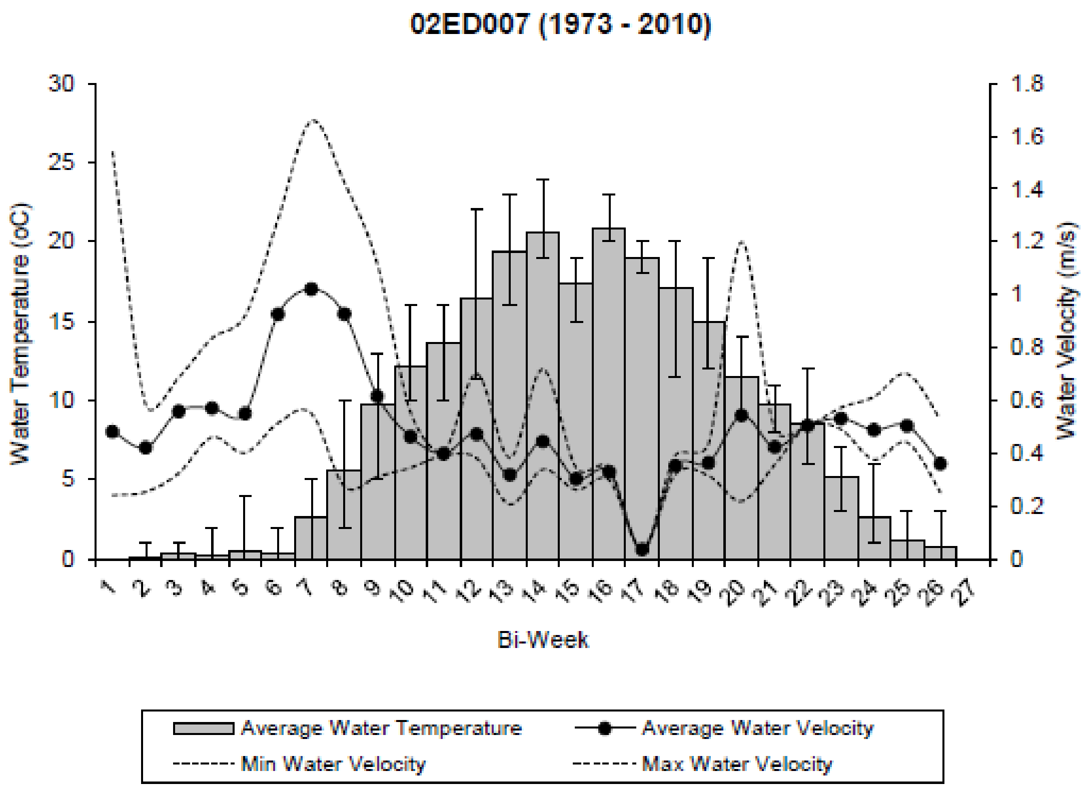
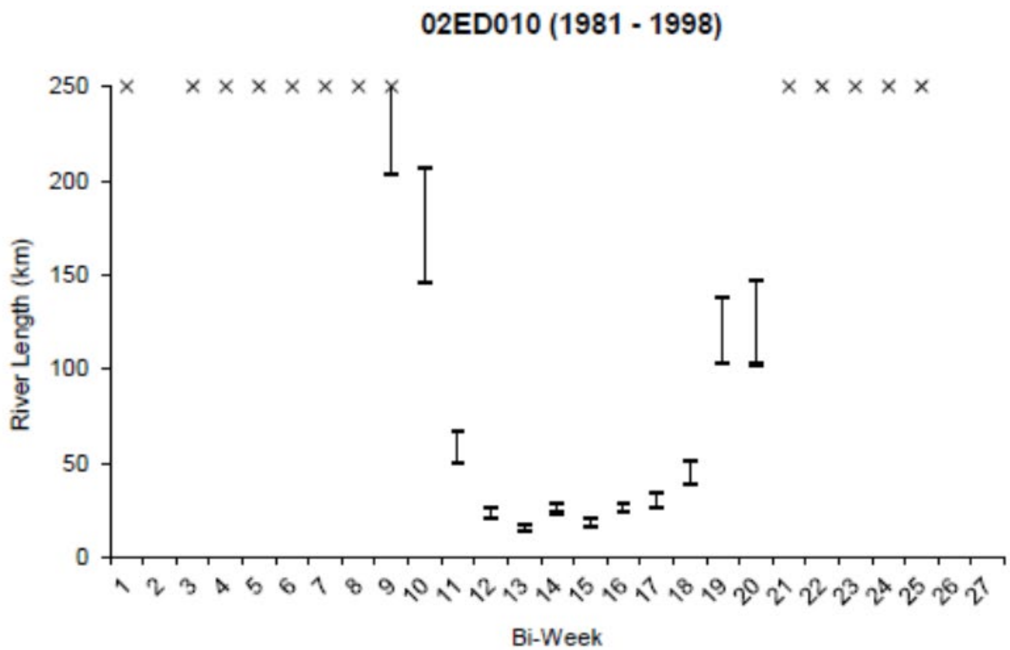


Figure A1-50. Gauging station 02ED007 data from 1973–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



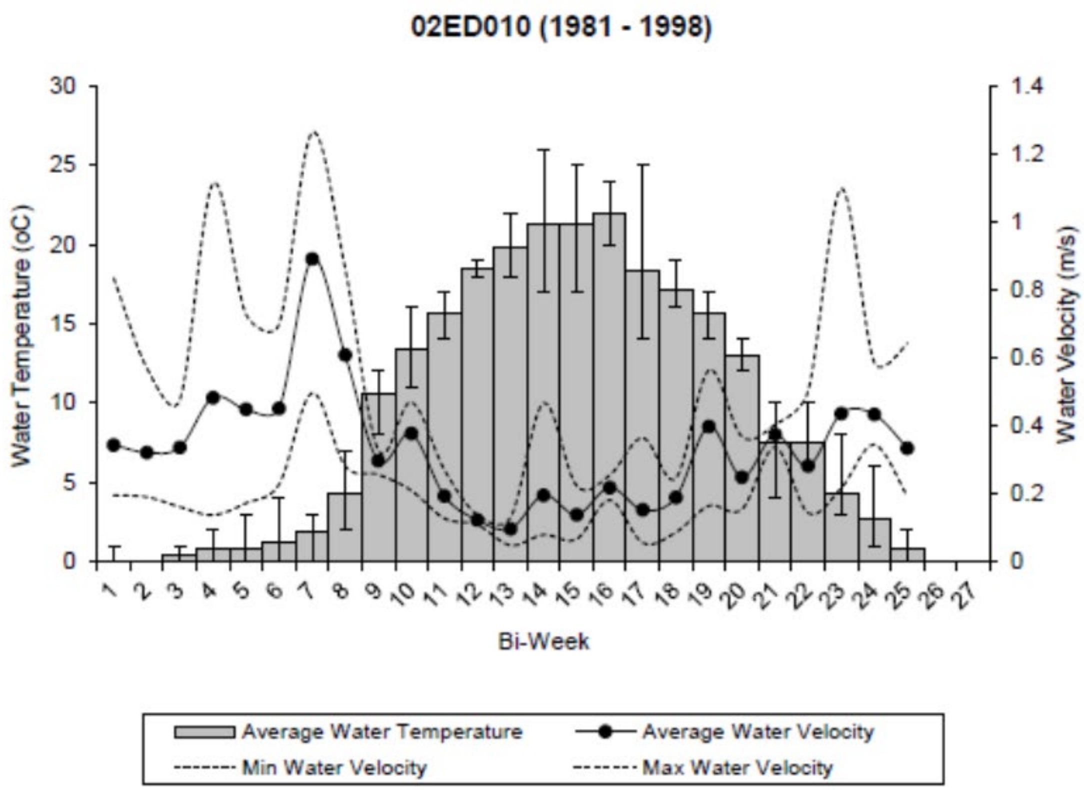
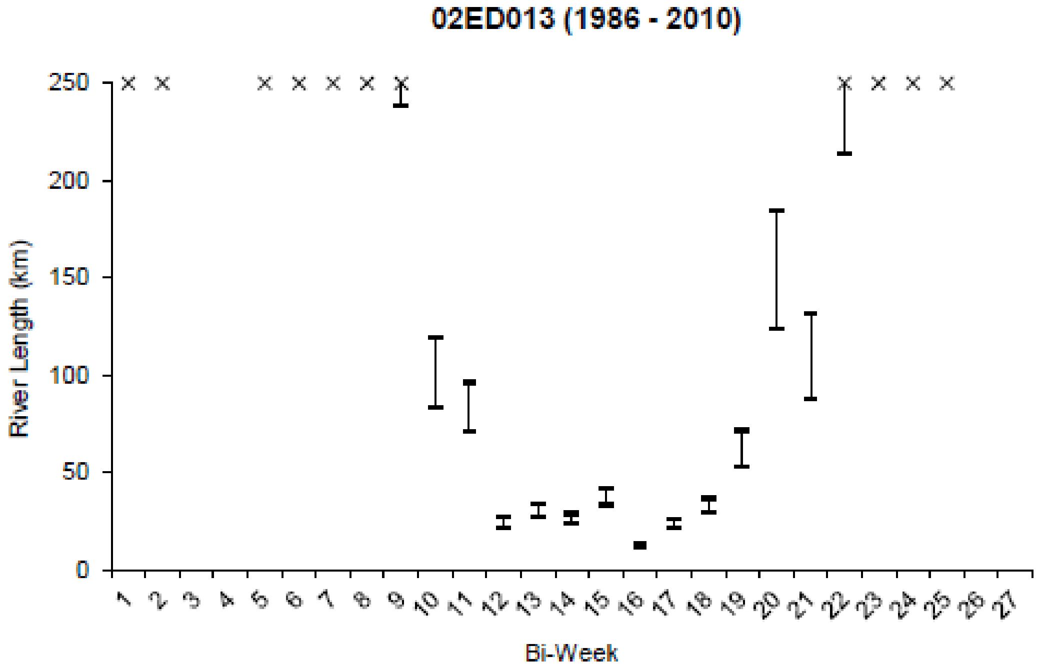


Figure A1-51. Gauging station 02ED010 data from 1981–1998. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



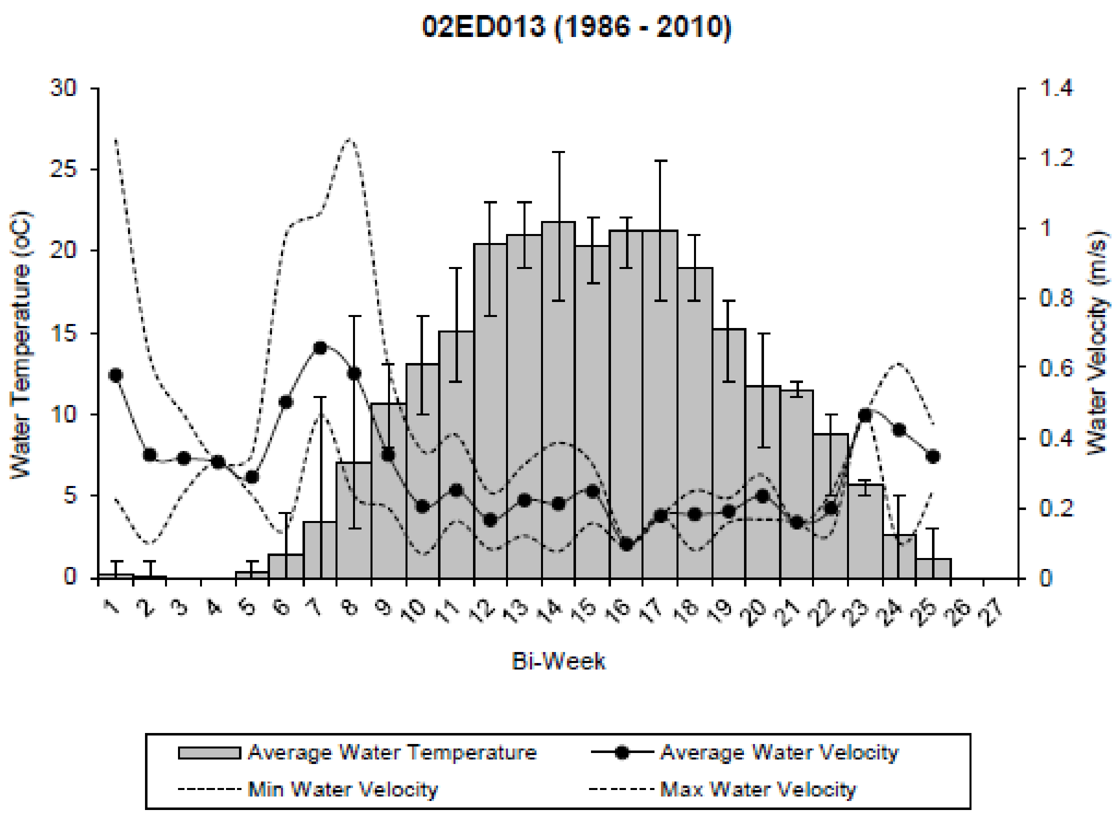
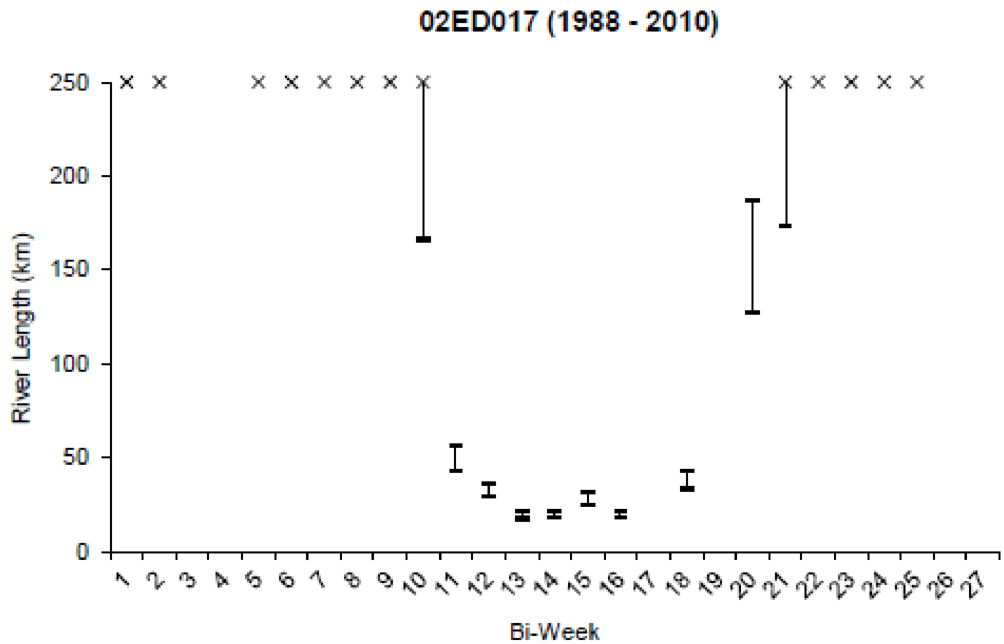


Figure A1-52. Gauging station 02ED013 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



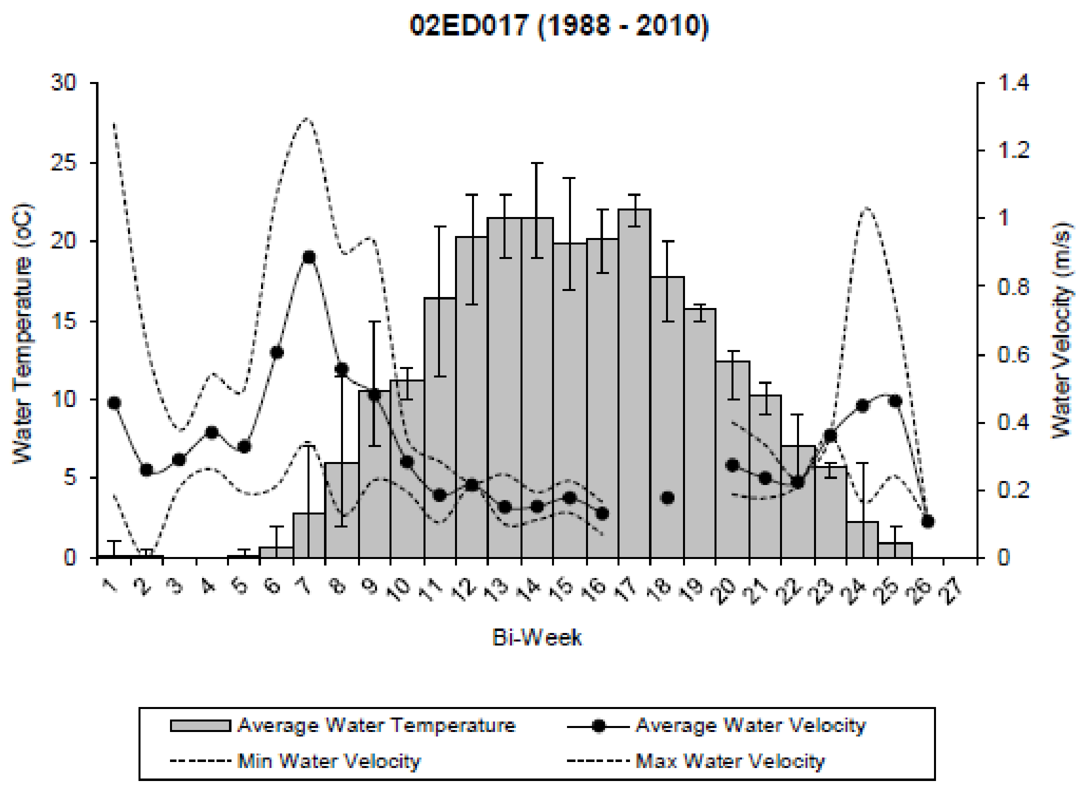
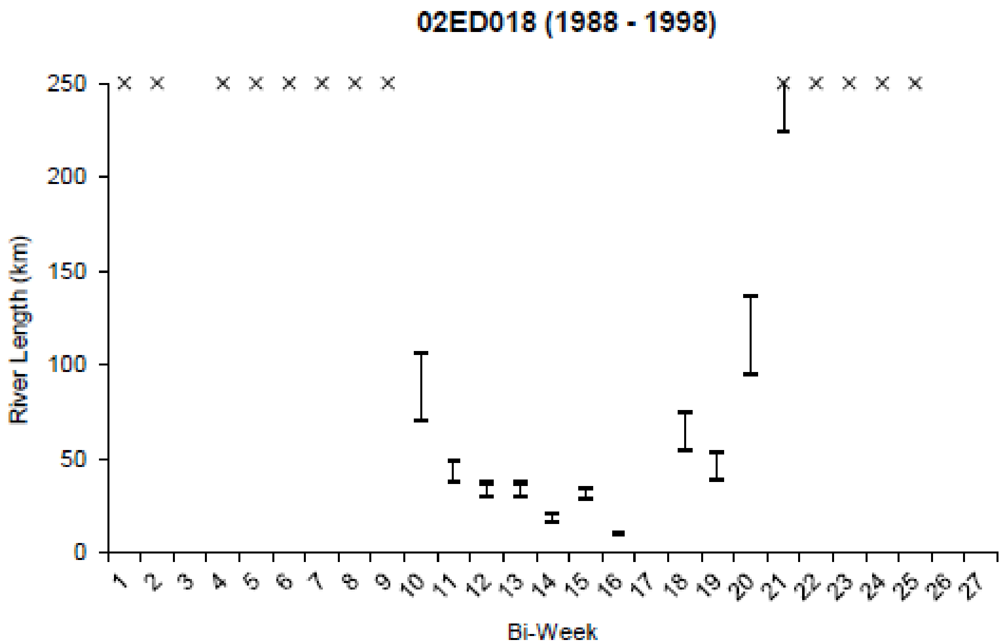


Figure A1-53. Gauging station 02ED017 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



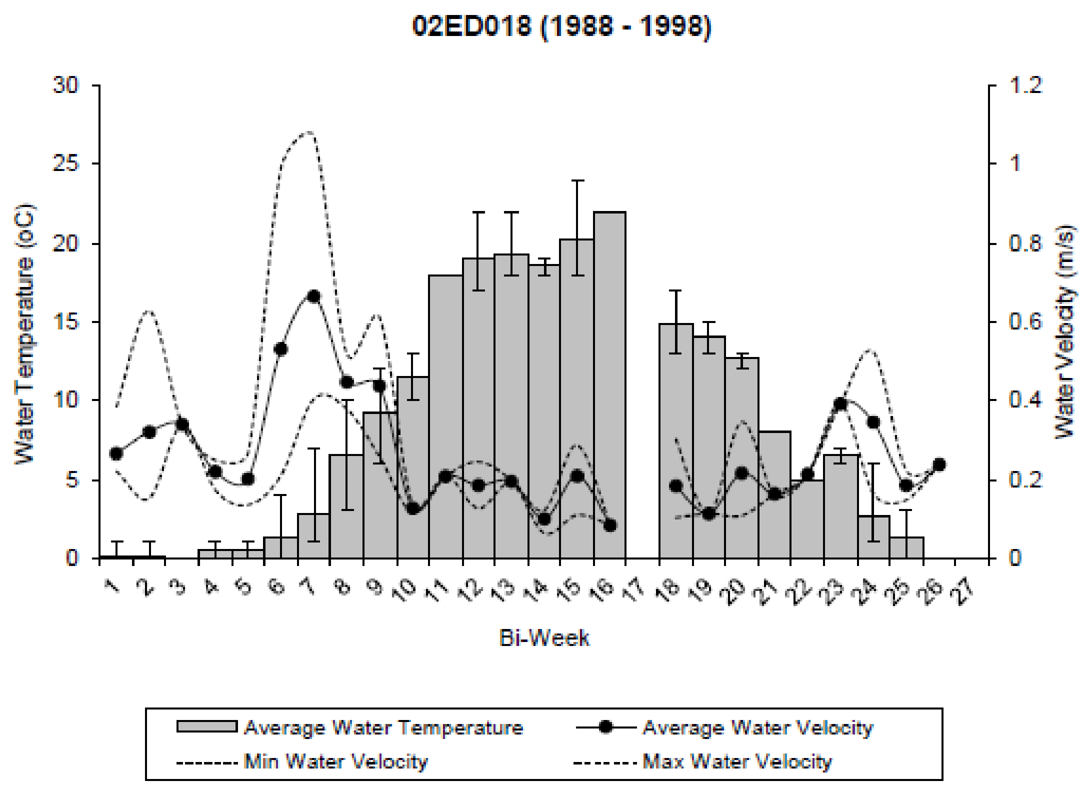
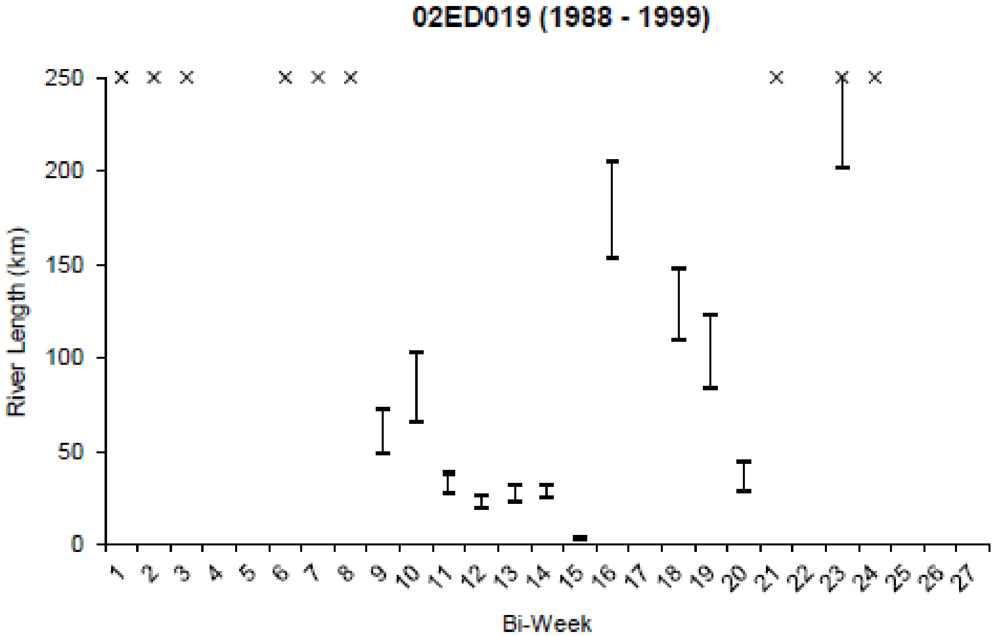


Figure A1-54. Gauging station 02ED018 data from 1988–1998. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



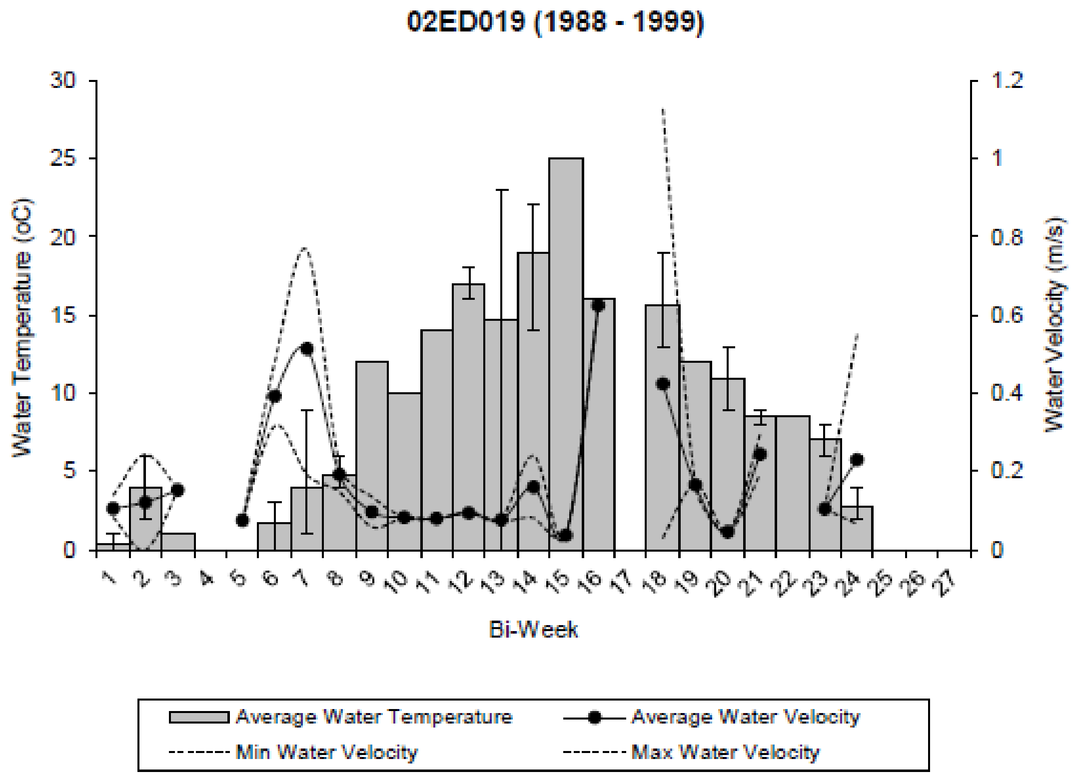
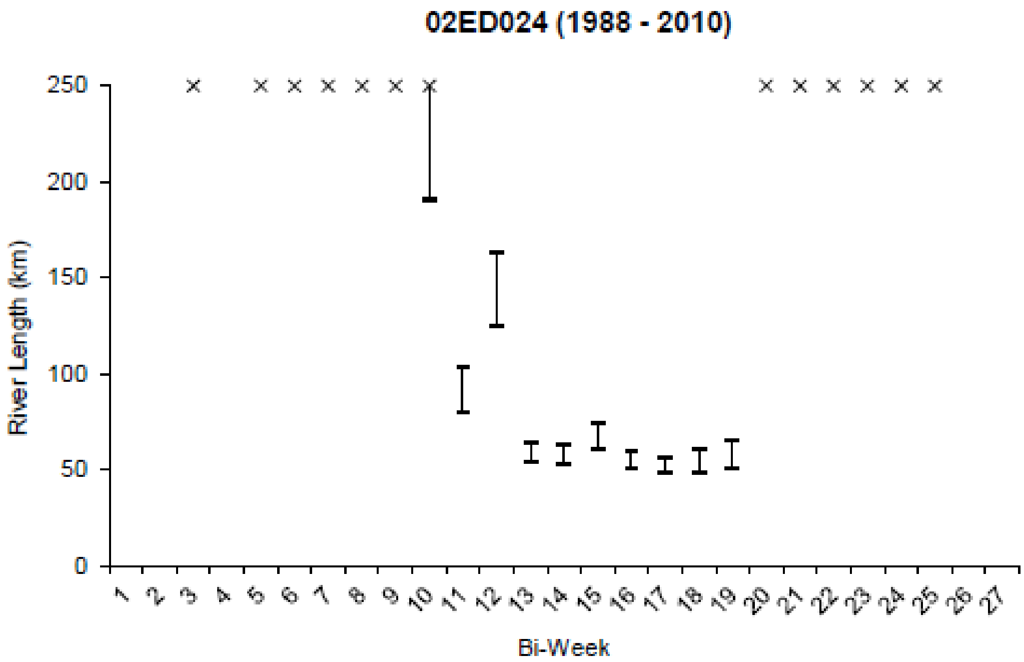


Figure A1-55. Gauging station 02ED019 data from 1988–1999. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



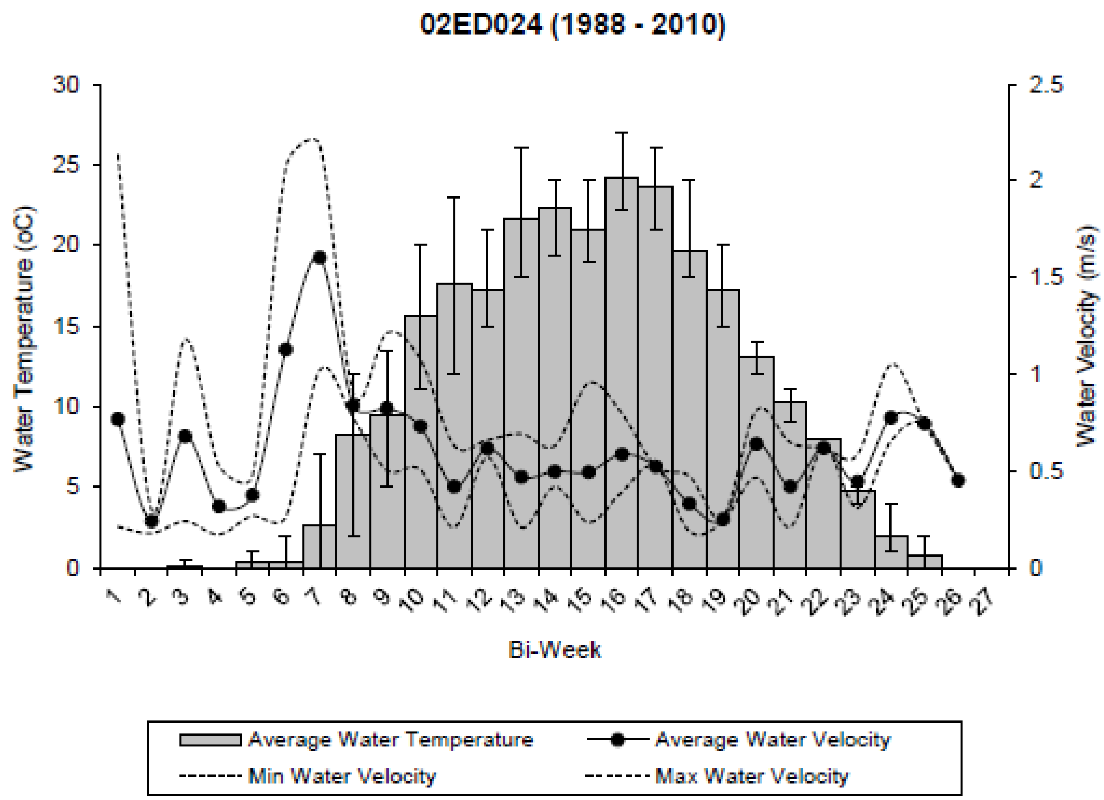
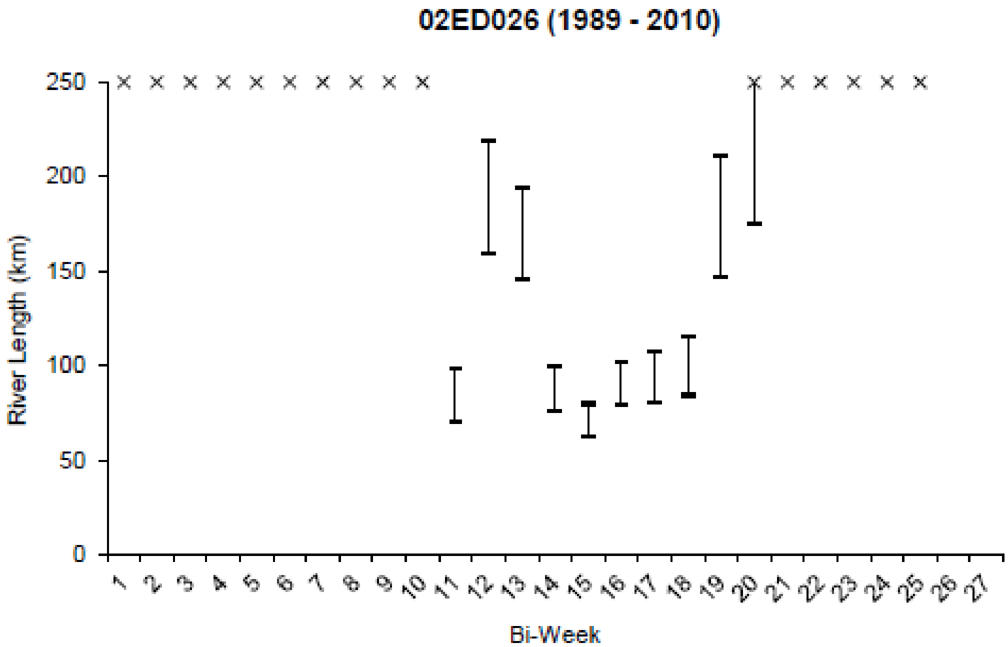


Figure A1-56. Gauging station 02ED024 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



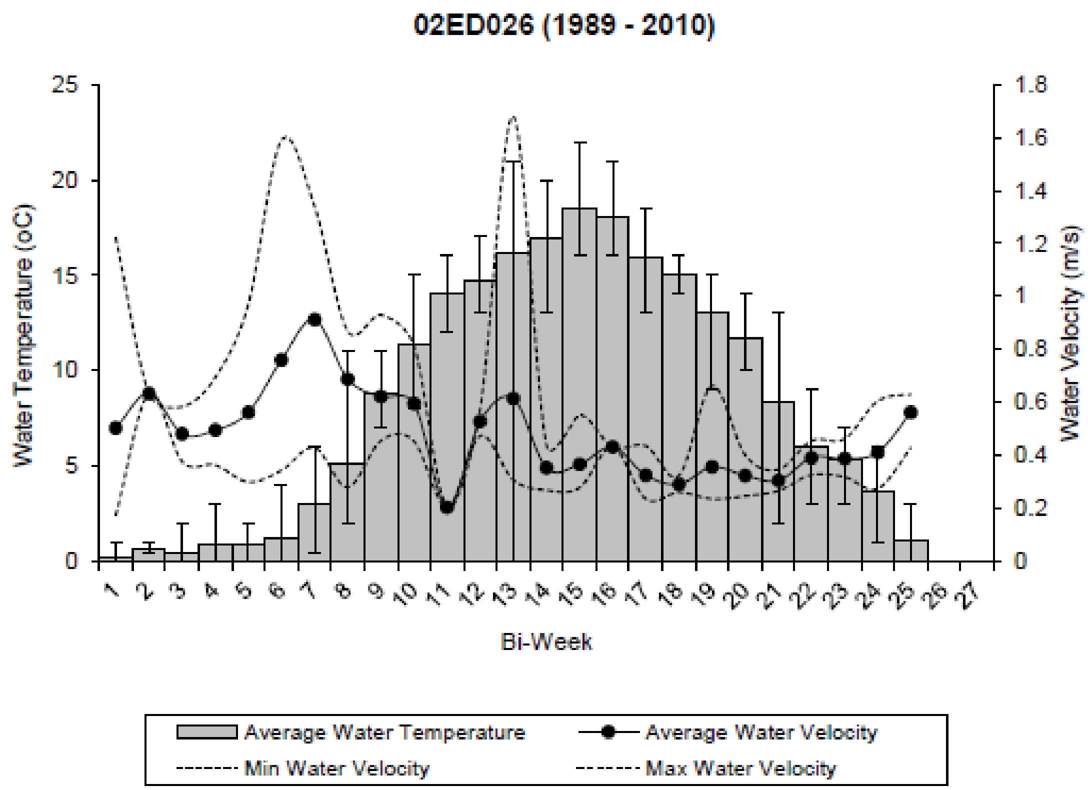


Figure A1-57. Gauging station 02ED026 data from 1989–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

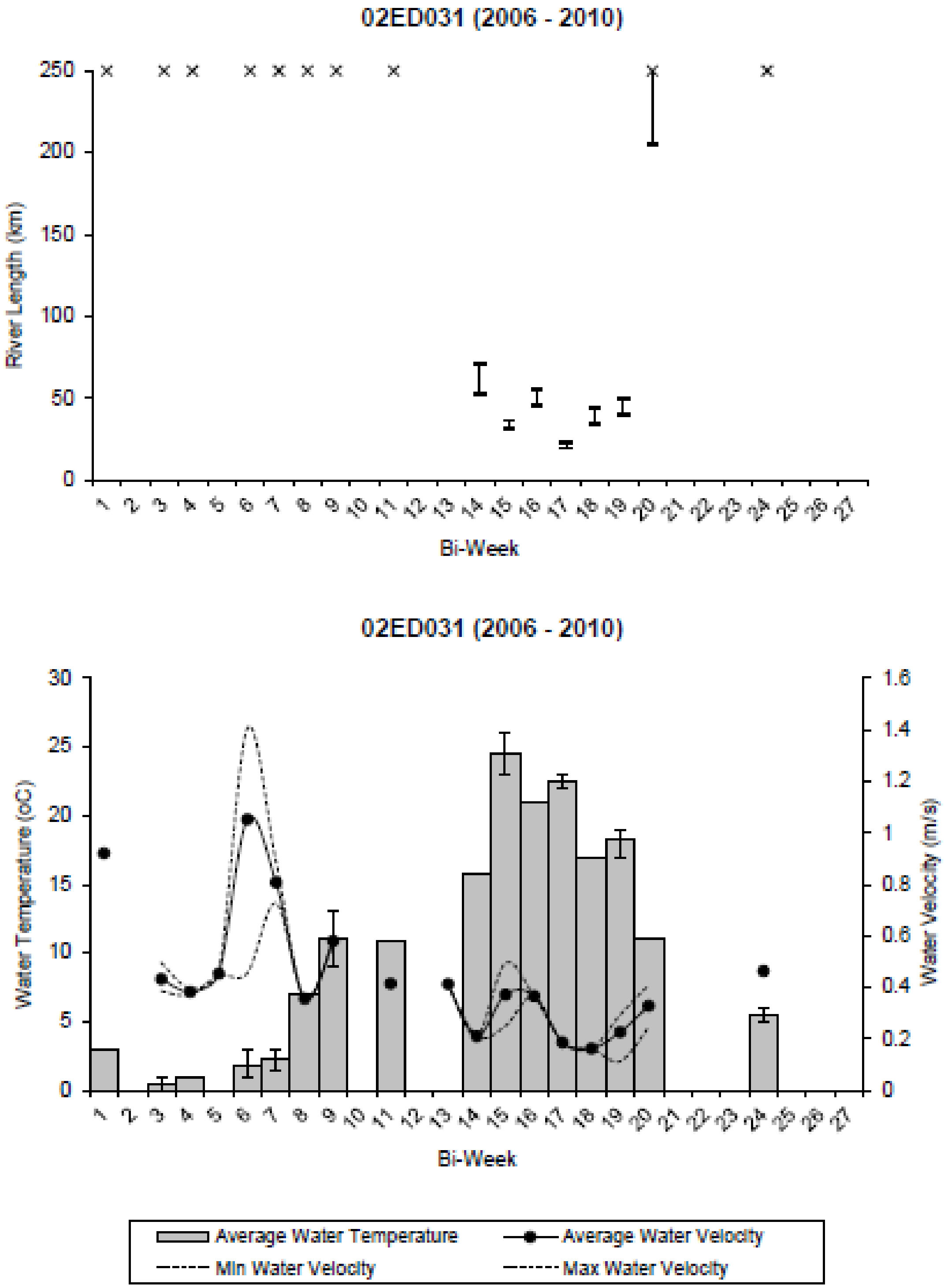
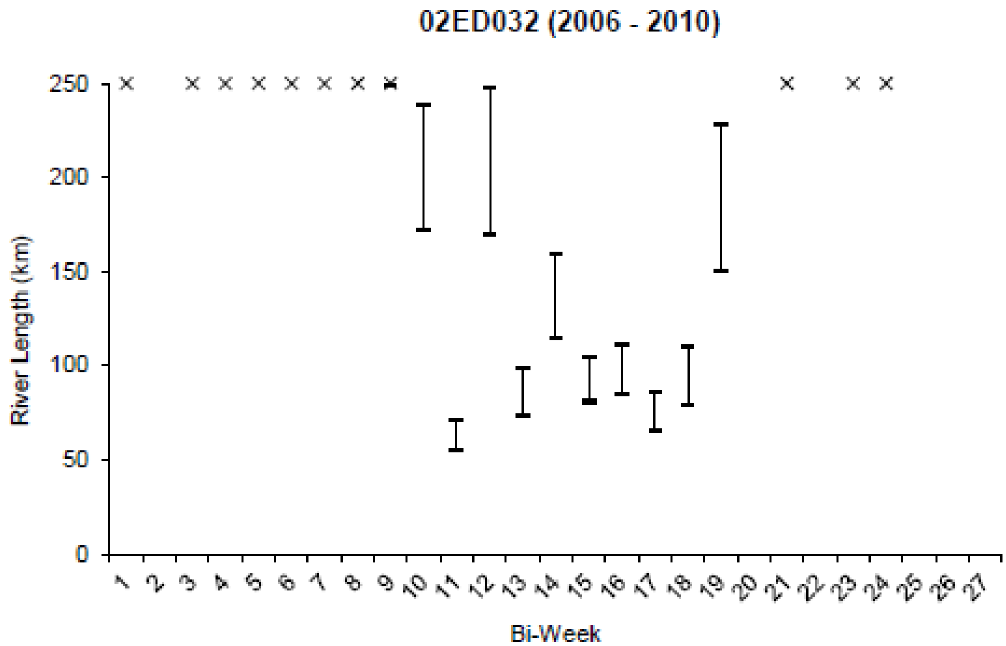


Figure A1-58. Gauging station 02ED031 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



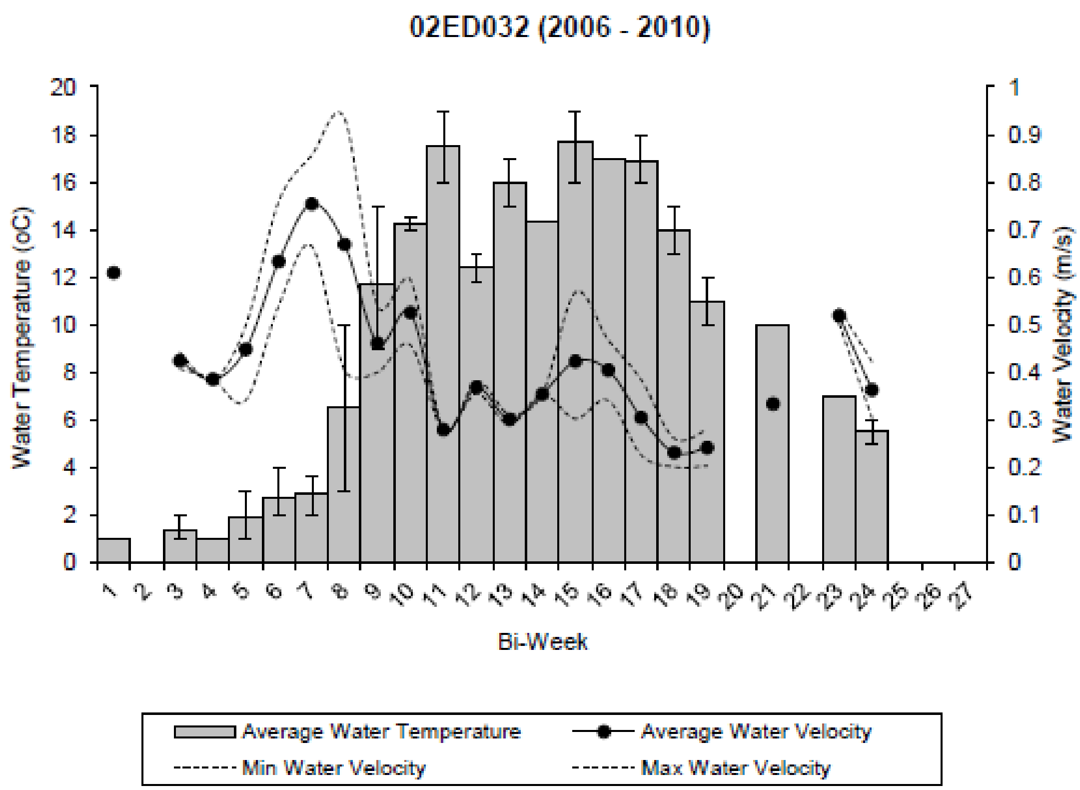
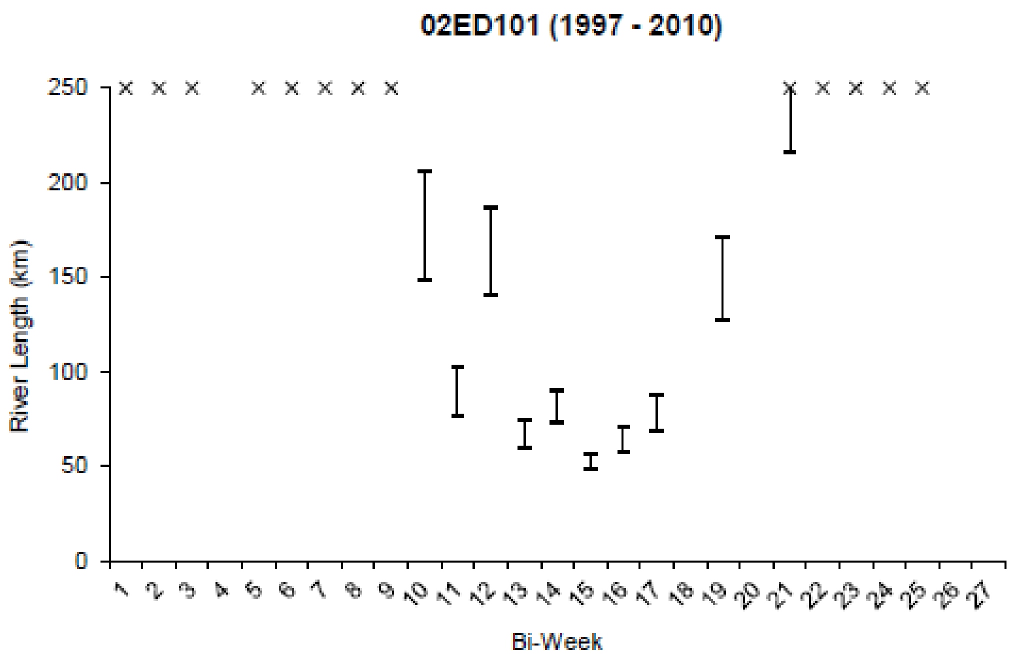


Figure A1-59. Gauging station 02ED032 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



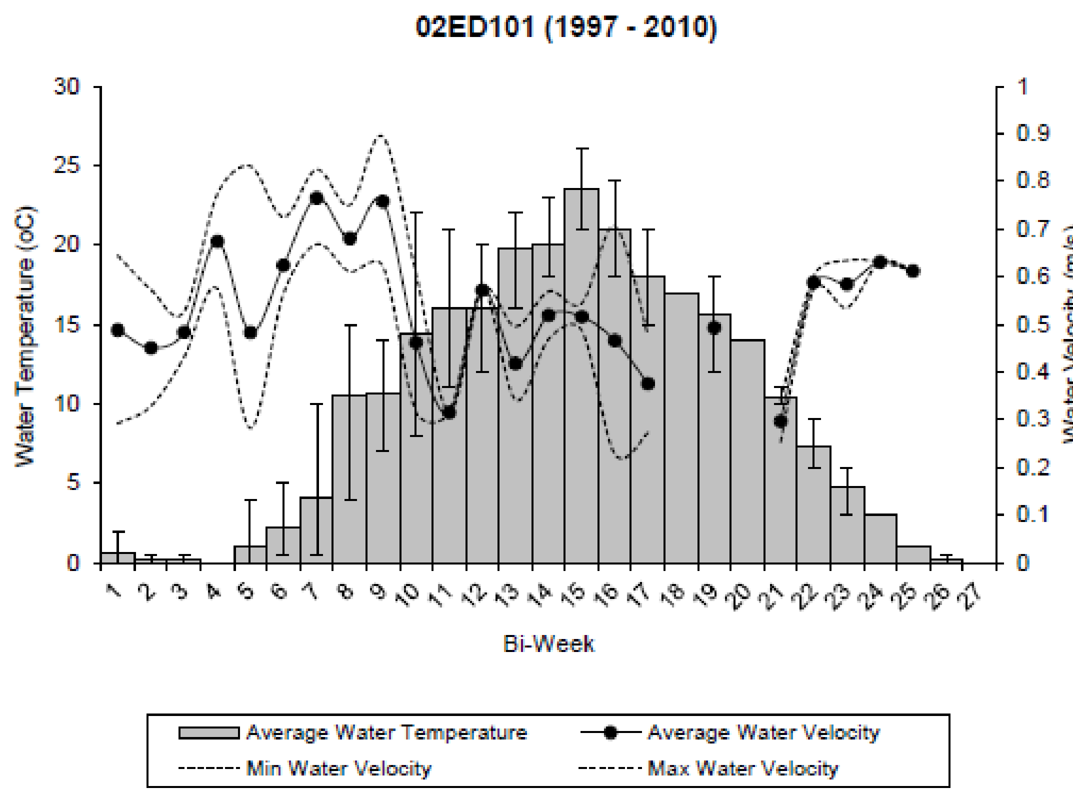
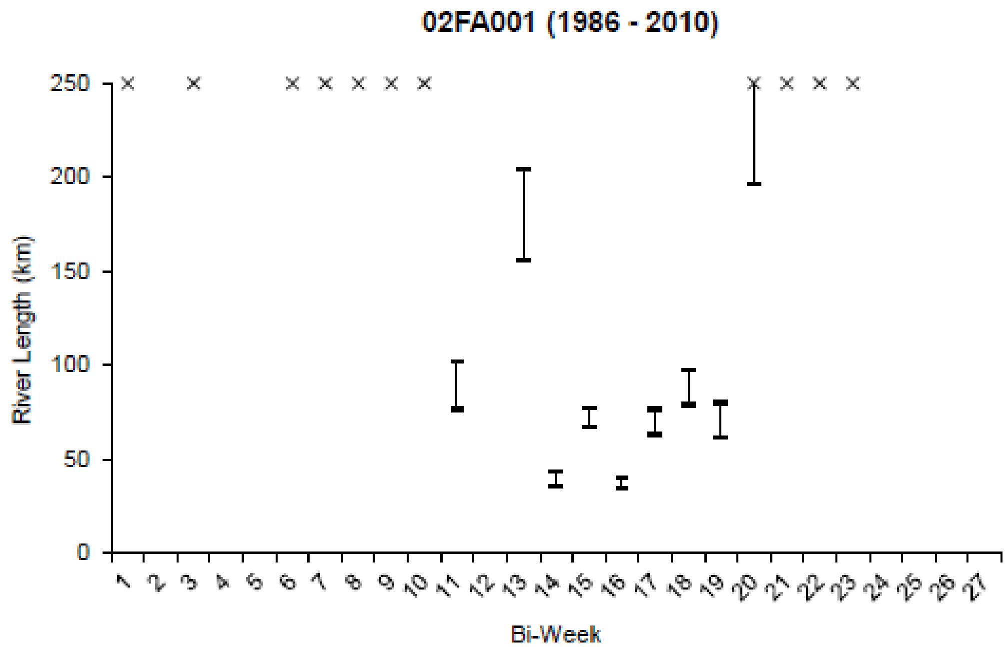


Figure A1-60. Gauging station 02ED101 data from 1997–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



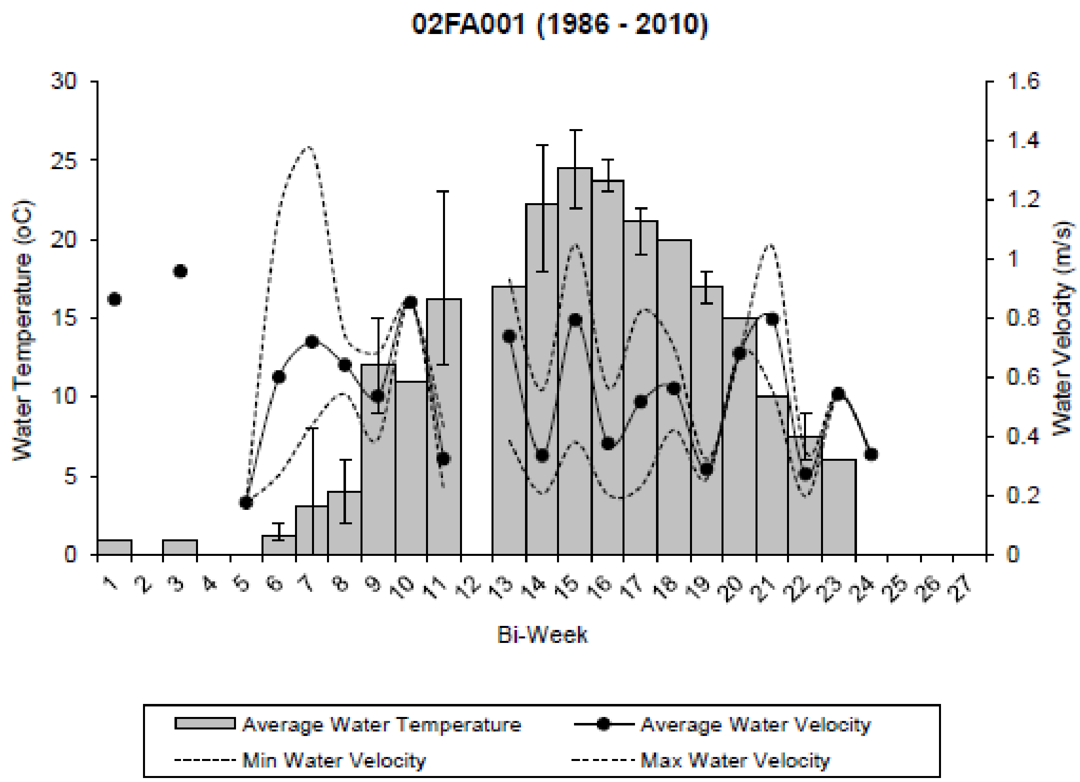
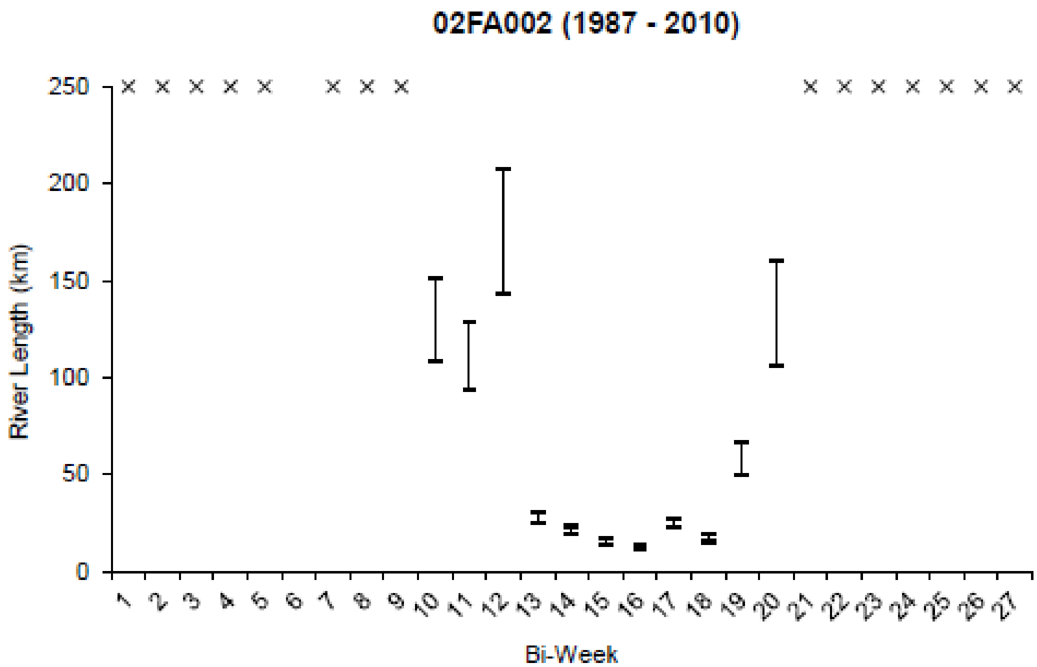


Figure A1-61. Gauging station 02FA001 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



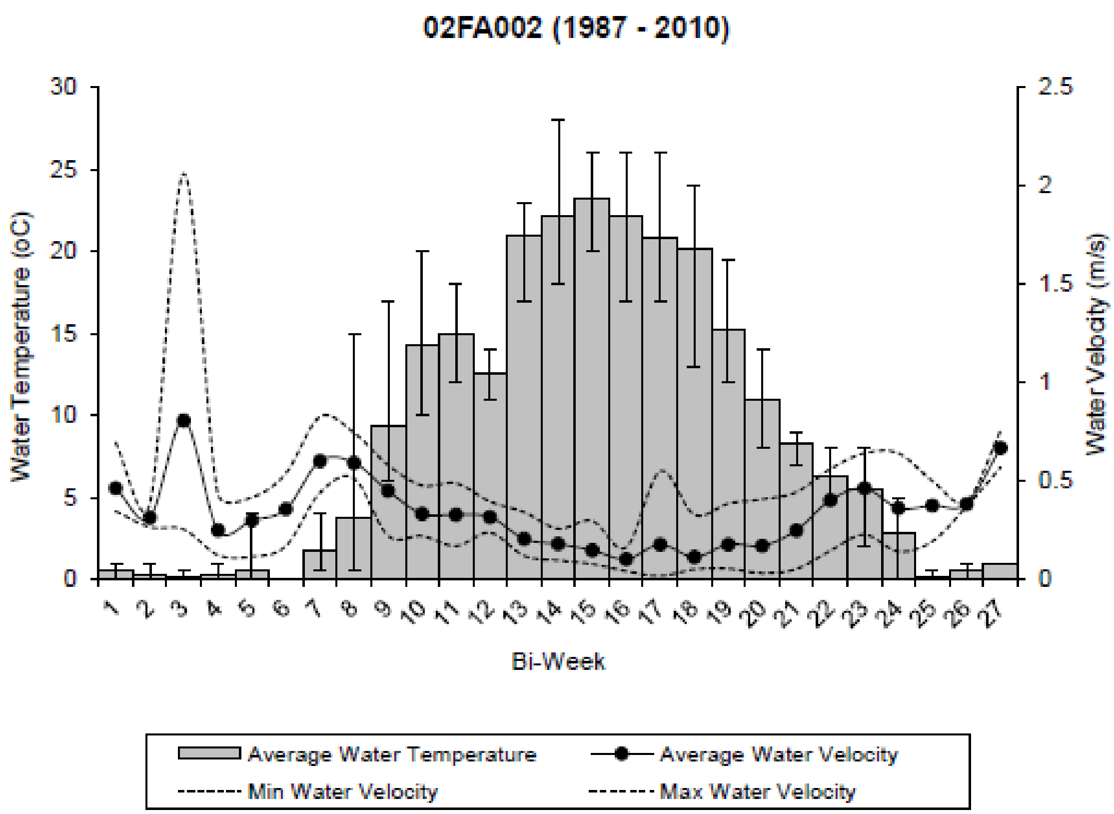
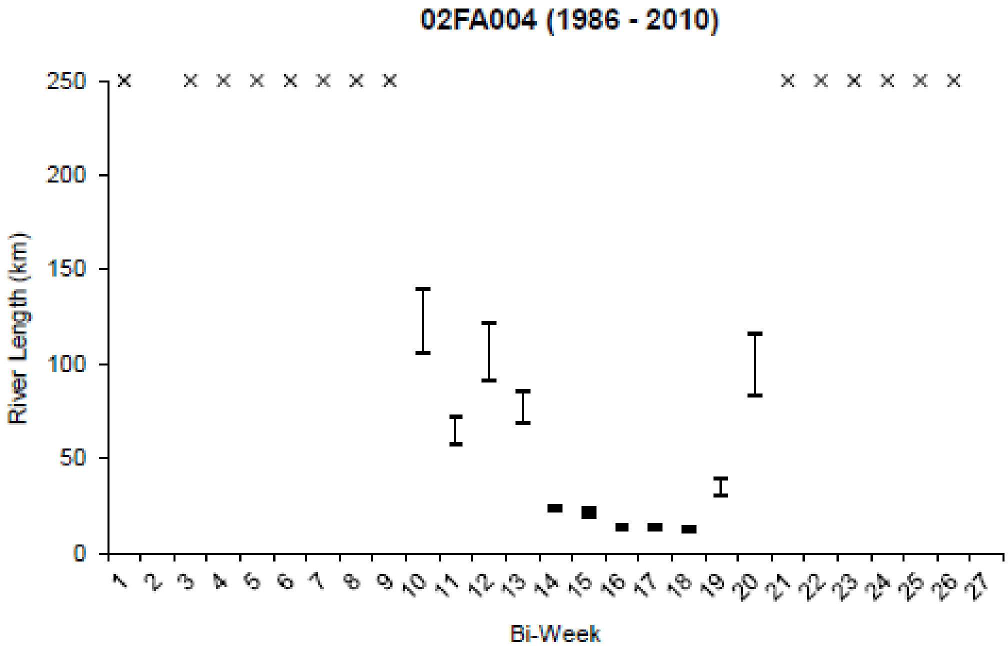


Figure A1-62. Gauging station 02FA002 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



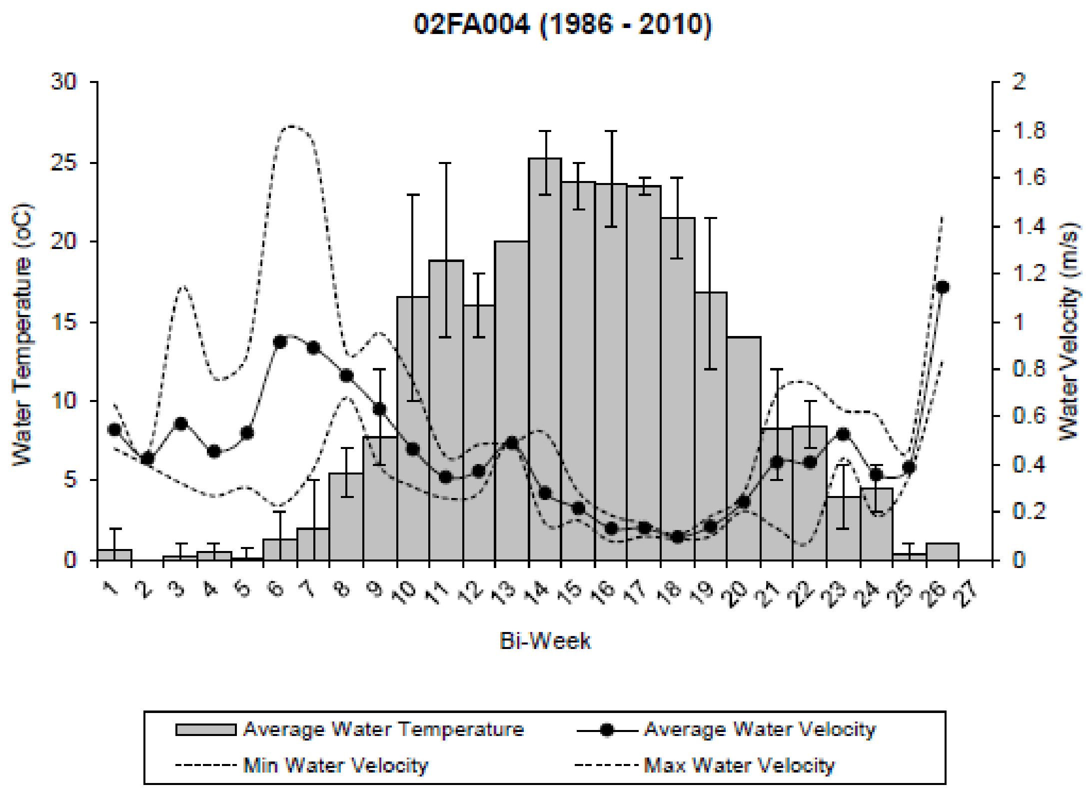


Figure A1-63. Gauging station 02FA004 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

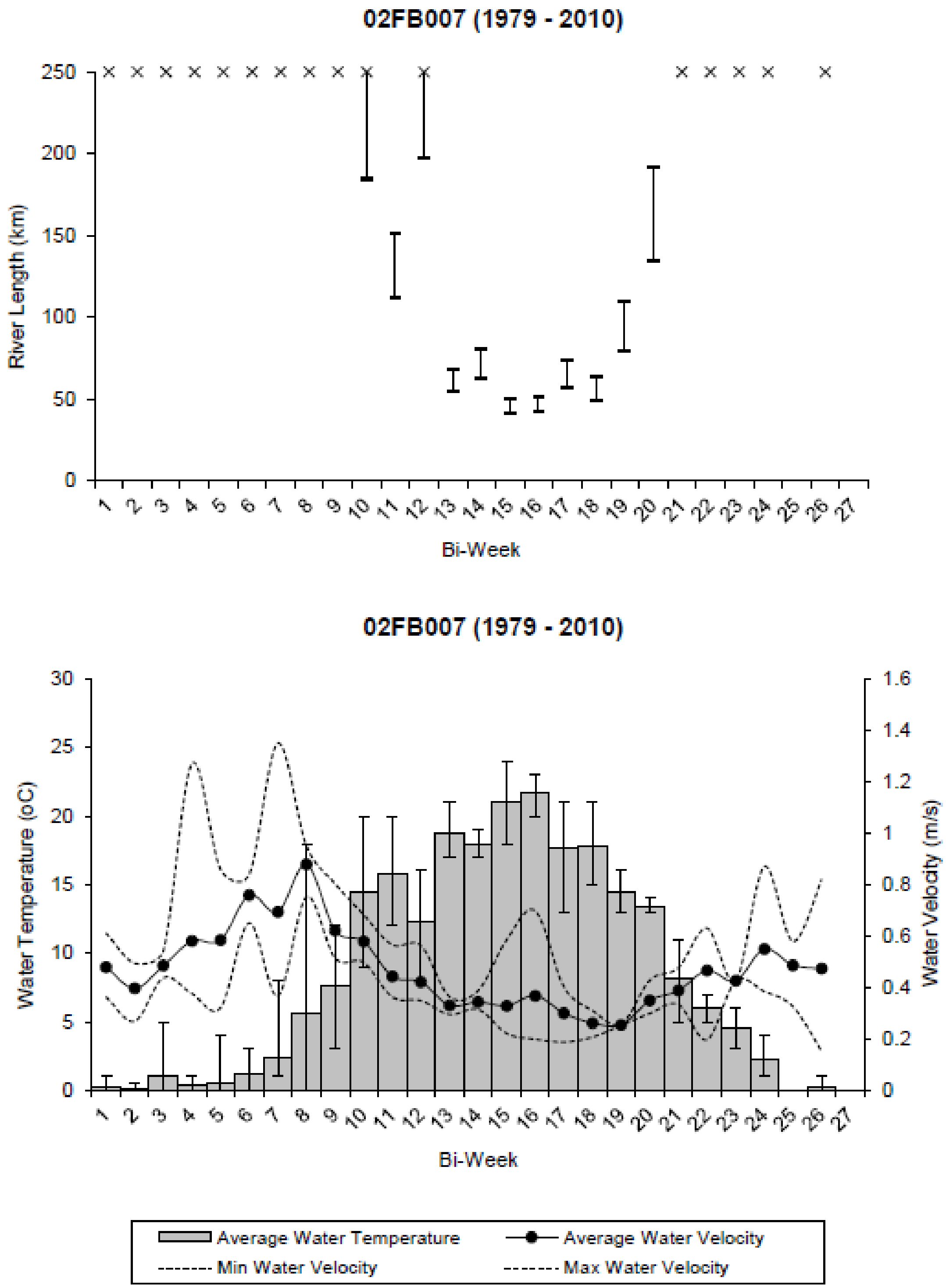


Figure A1-64. Gauging station 02FB007 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

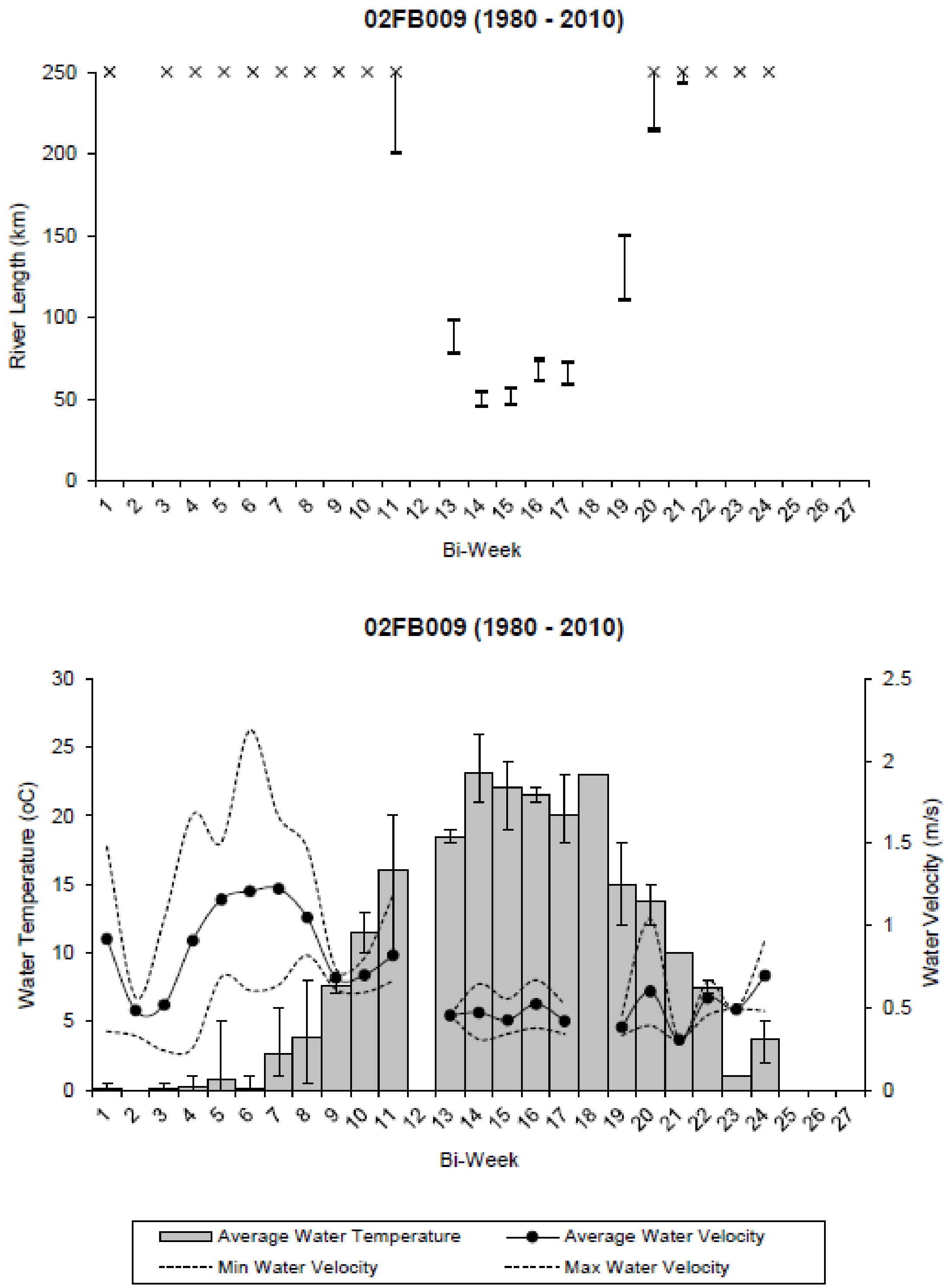
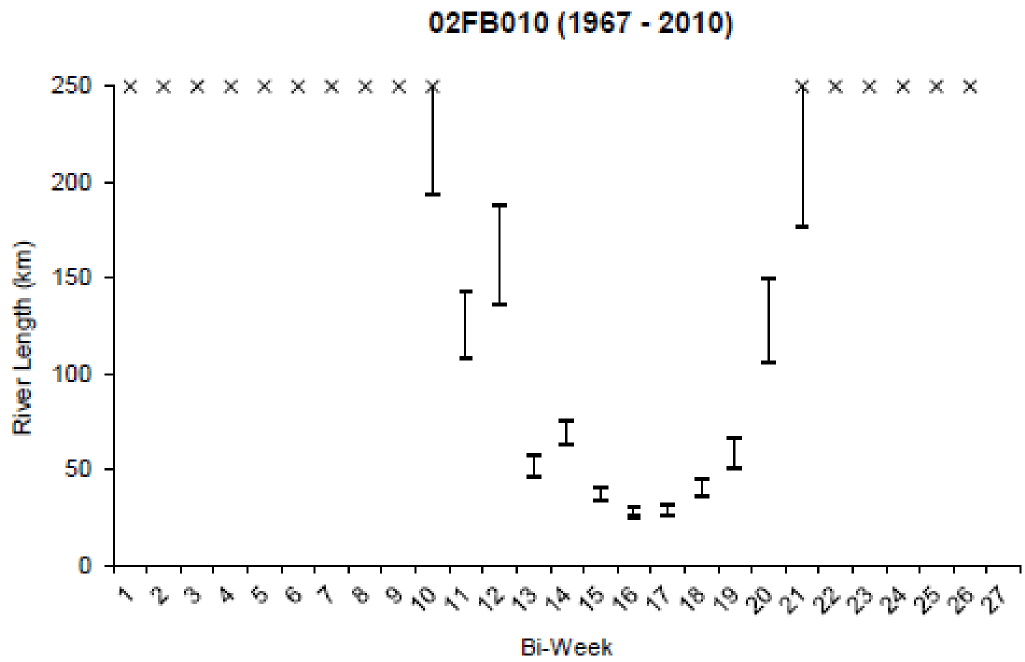


Figure A1-65. Gauging station 02FB009 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



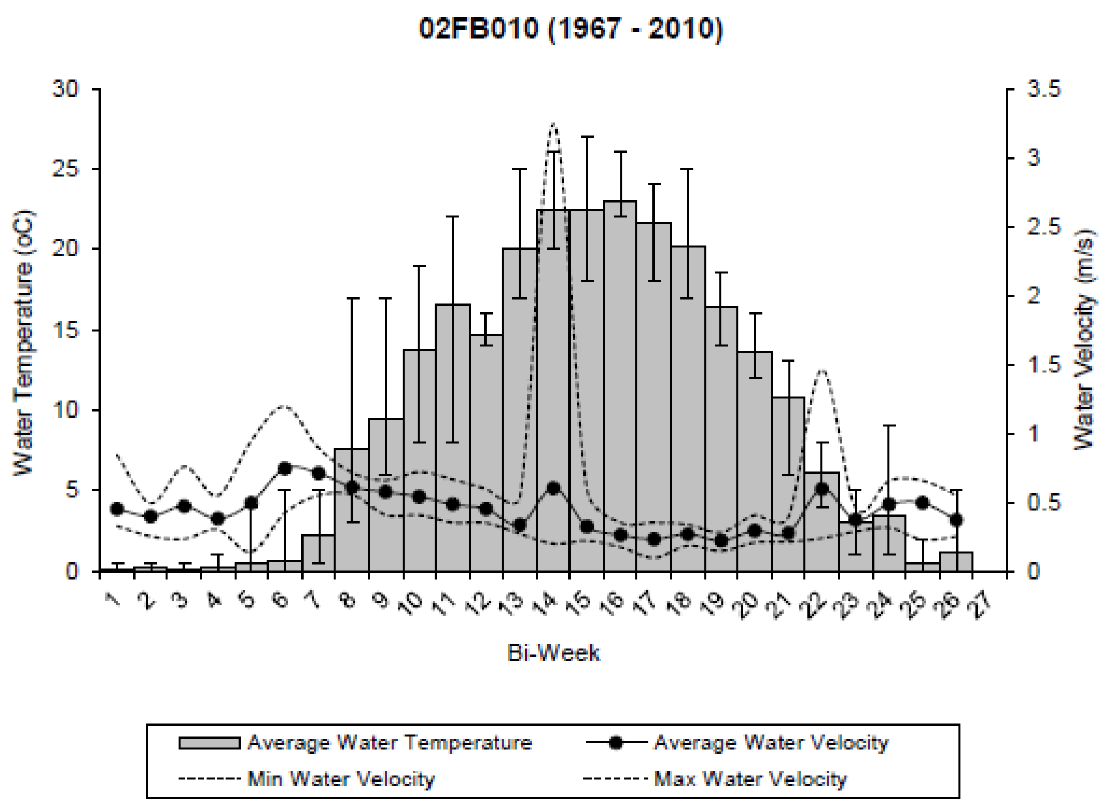


Figure A1-66. Gauging station 02FB010 data from 1967–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

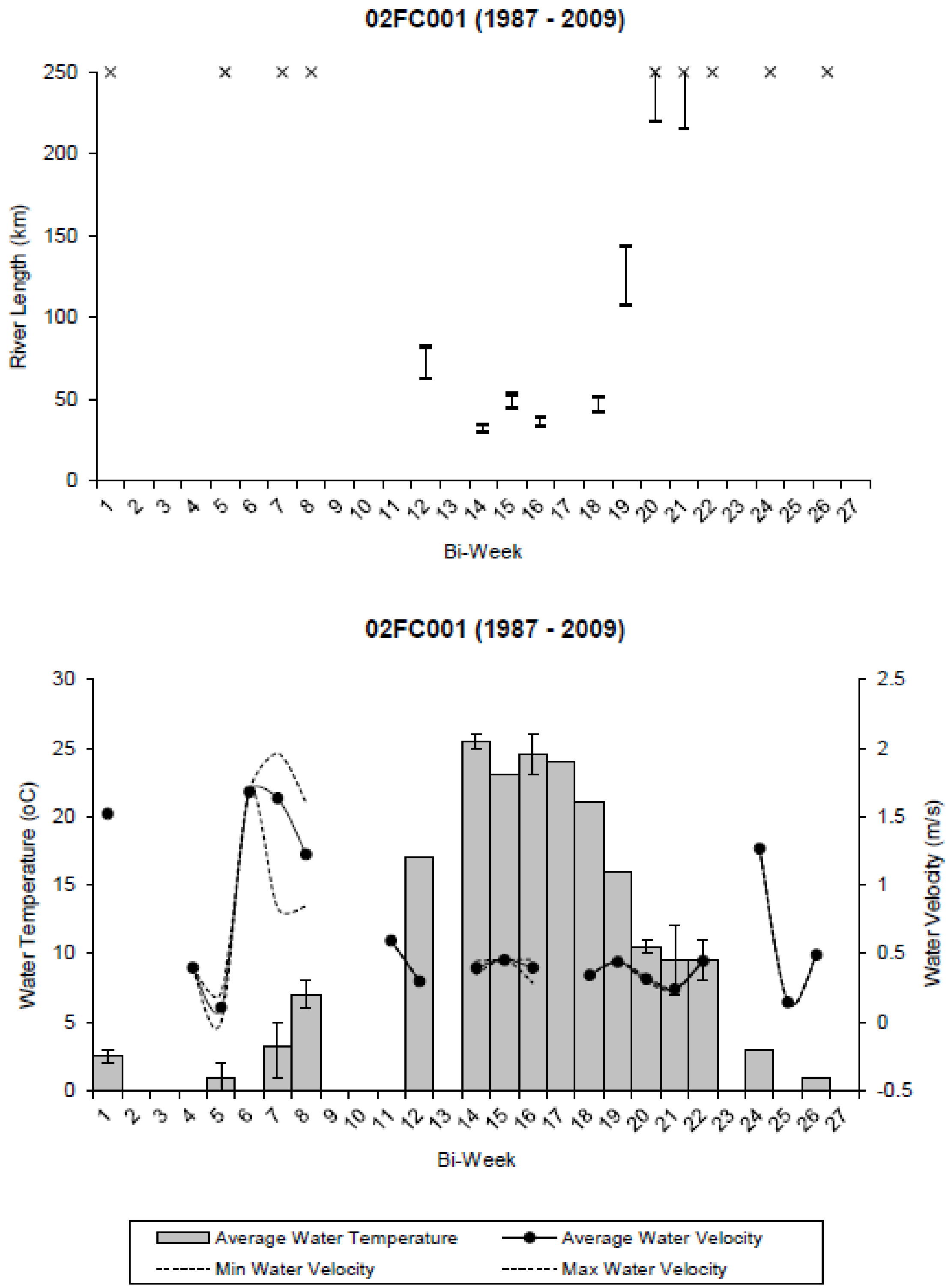
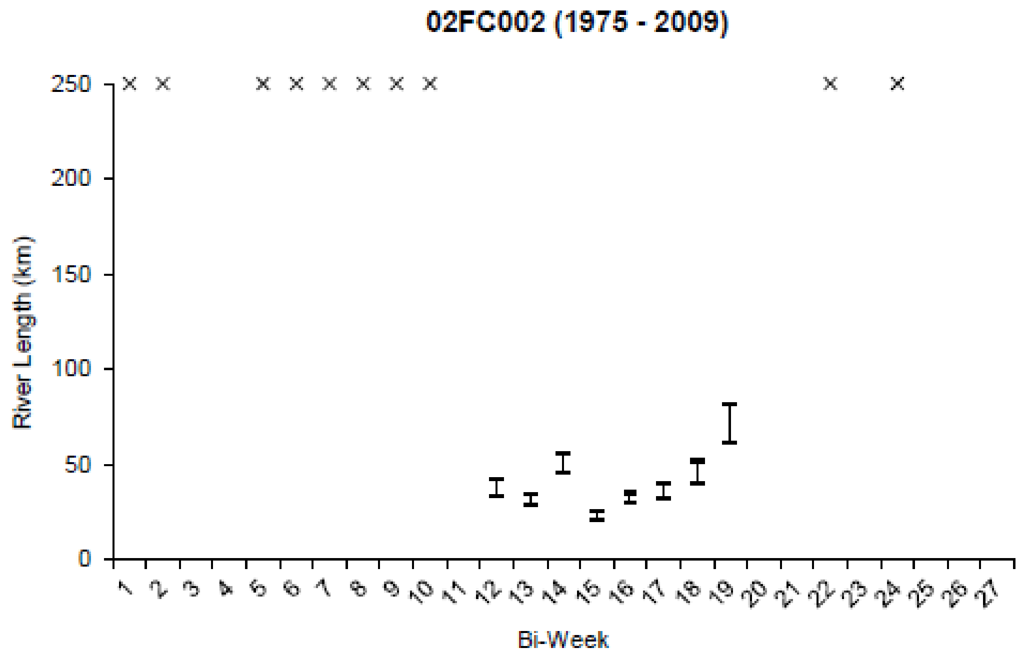


Figure A1-67. Gauging station 02FC001 data from 1987–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



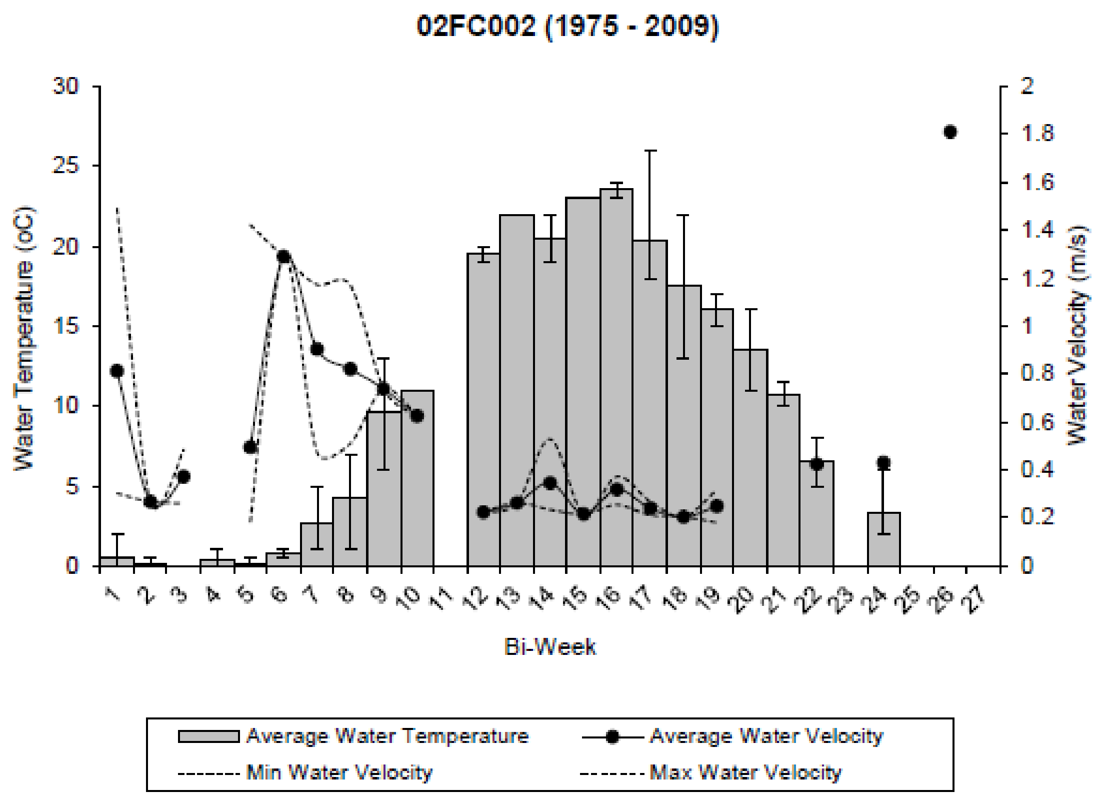


Figure A1-68. Gauging station 02FC002 data from 1975–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

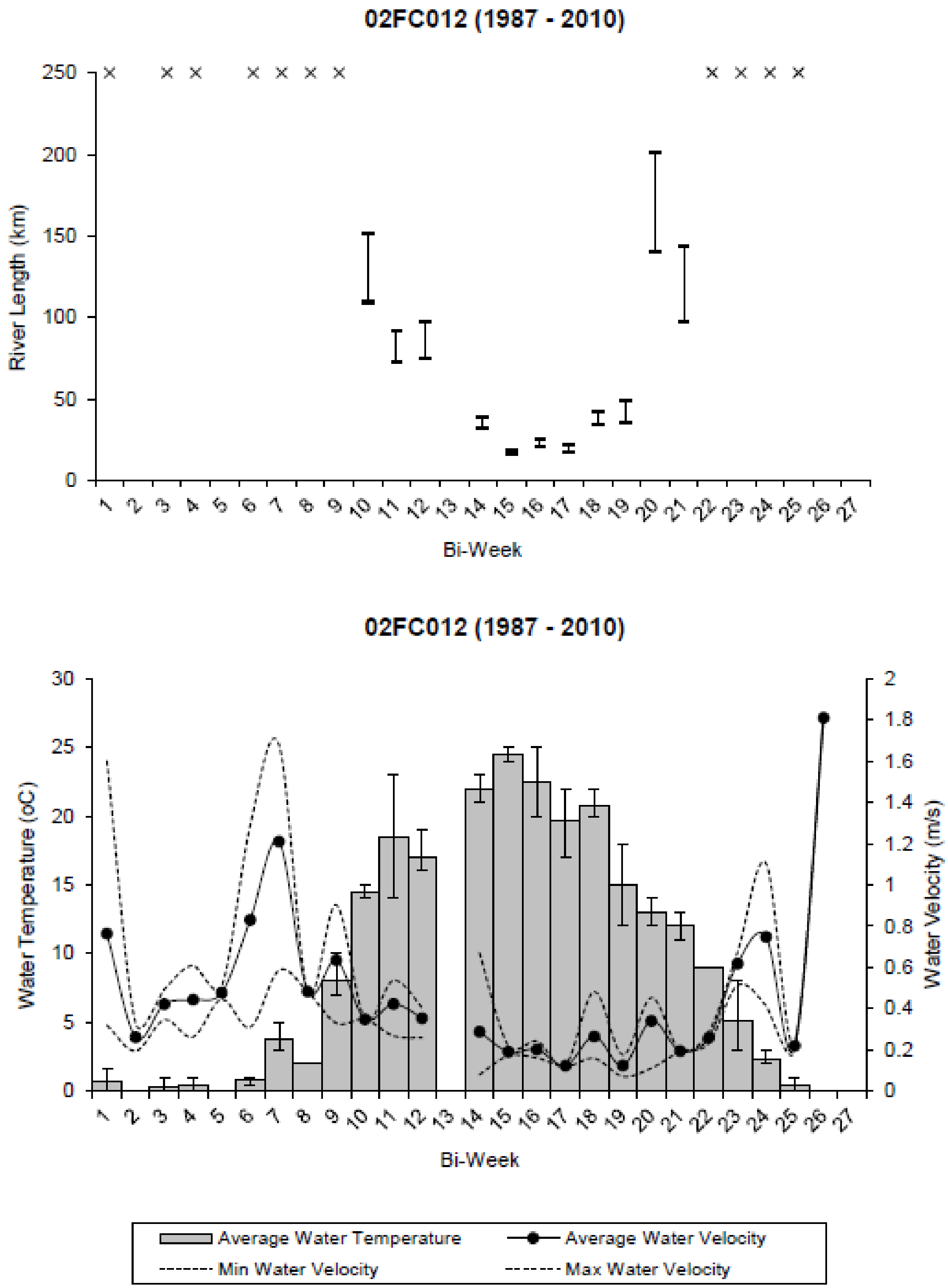
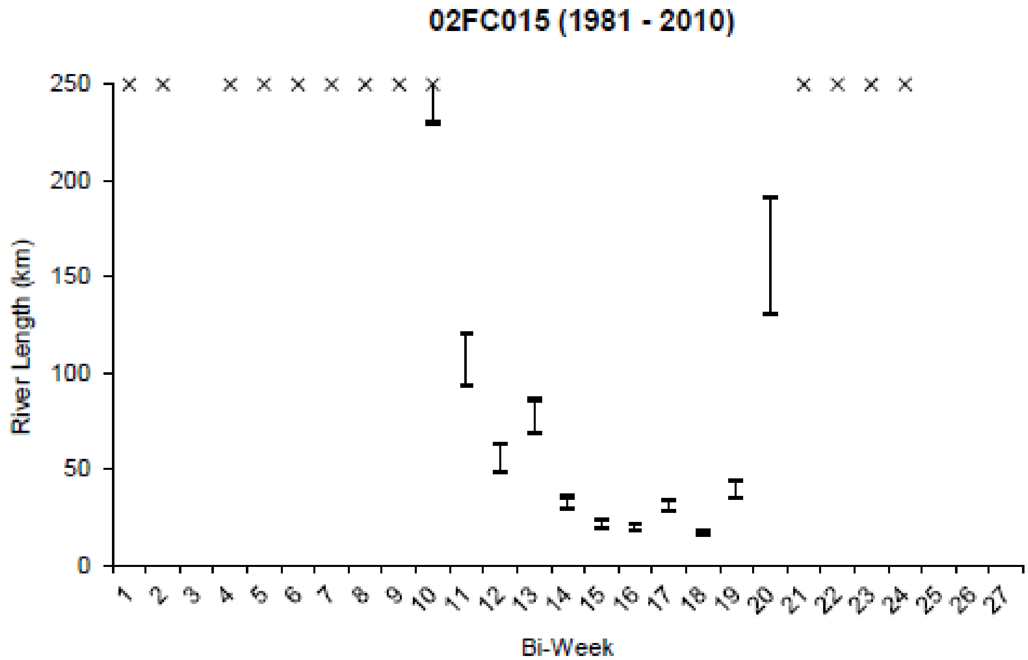


Figure A1-69. Gauging station 02FC012 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



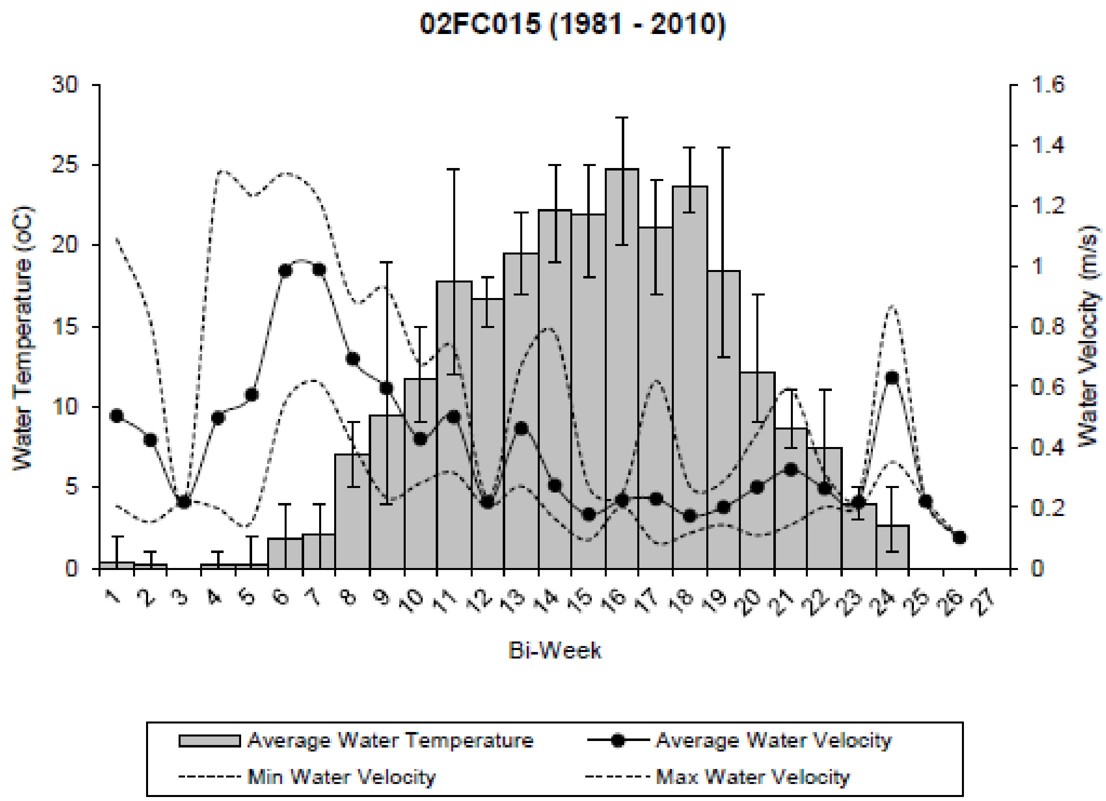
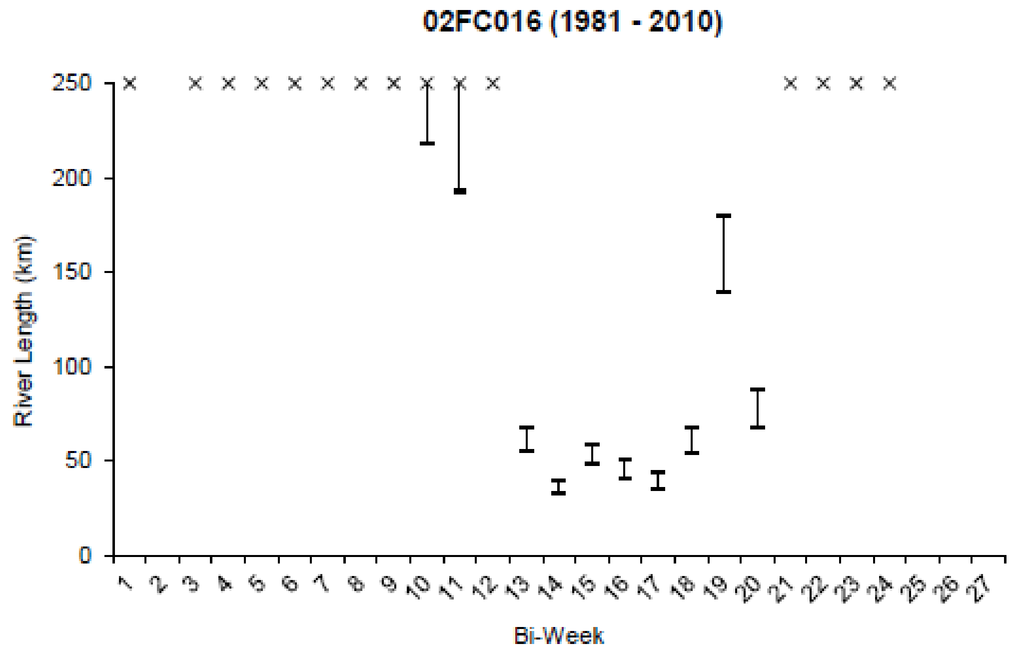


Figure A1-70. Gauging station 02FC015 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



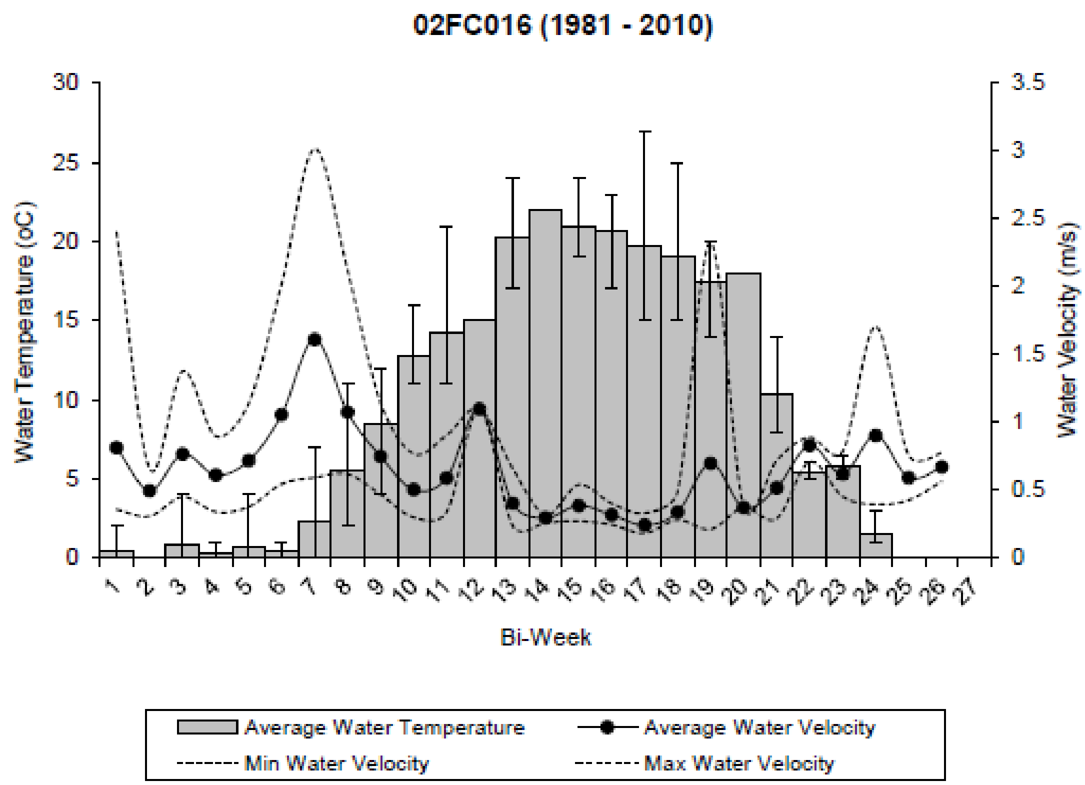
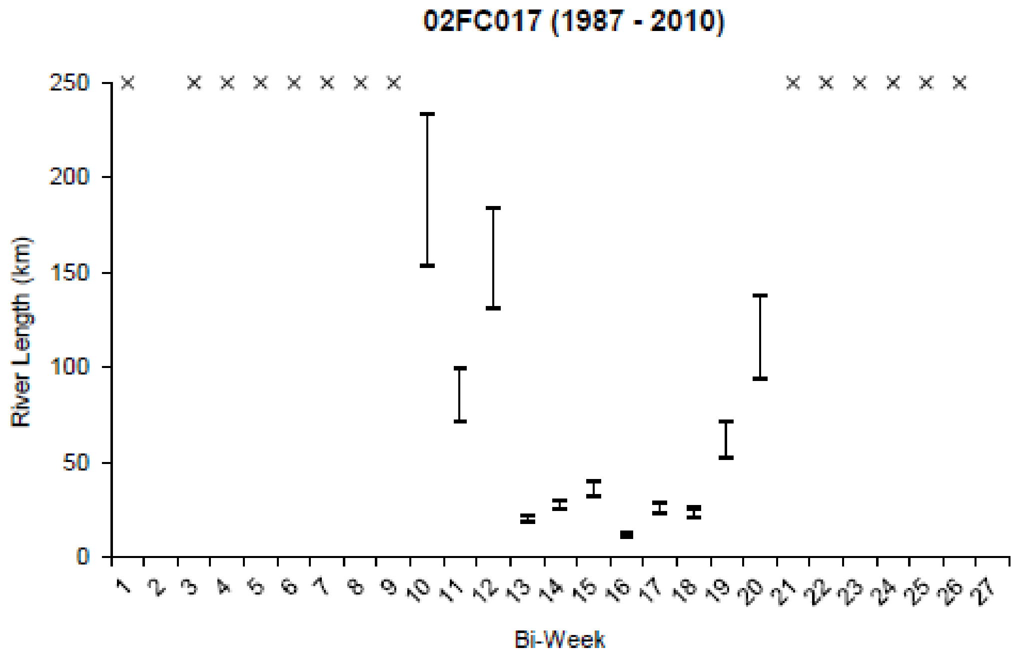


Figure A1-71. Gauging station 02FC016 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



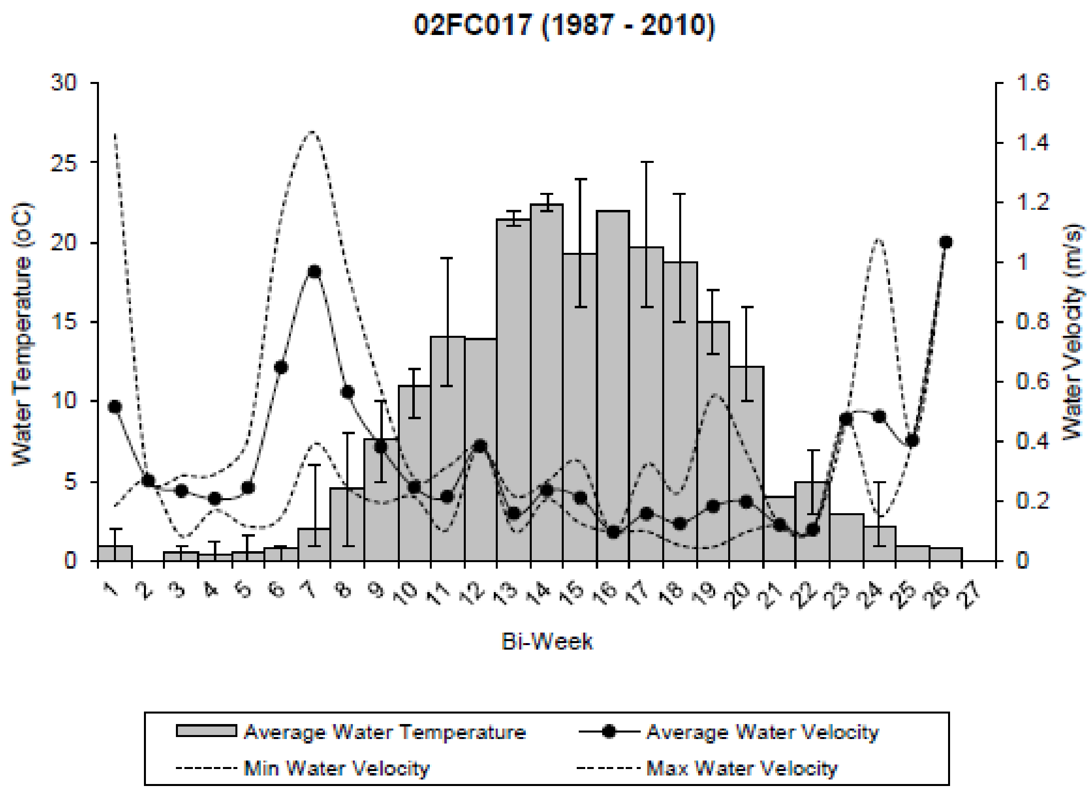
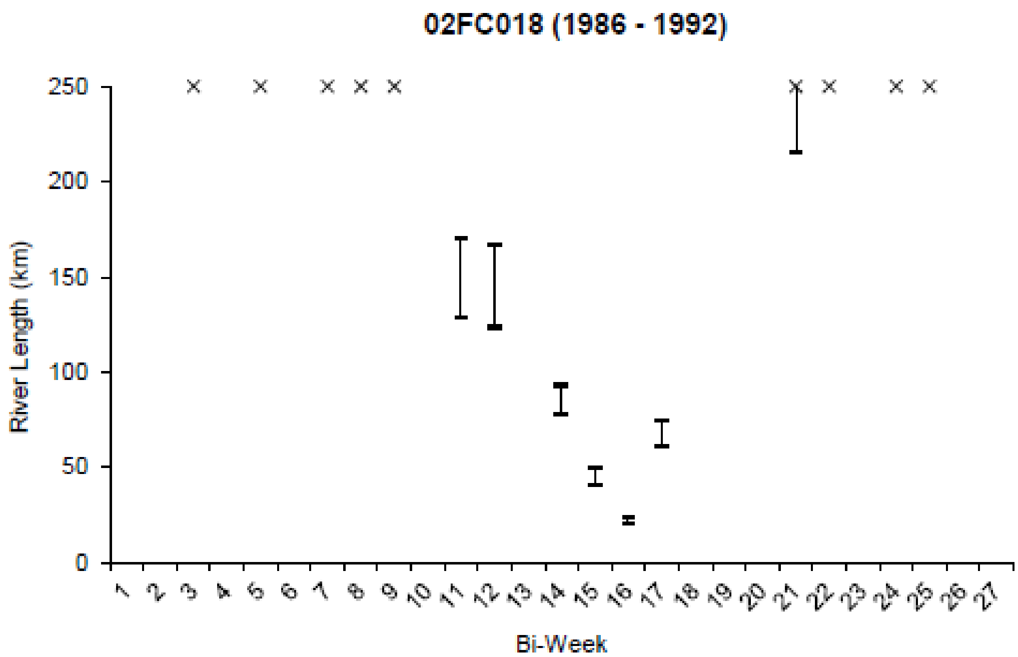


Figure A1-72. Gauging station 02FC017 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



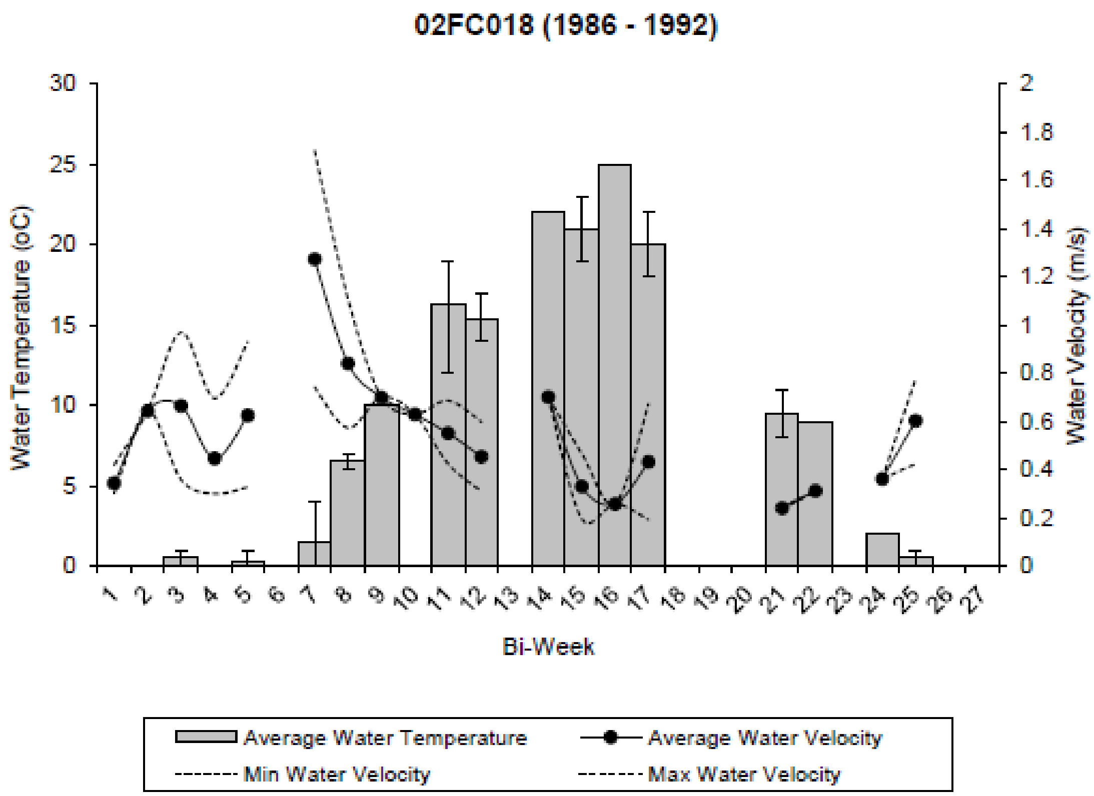
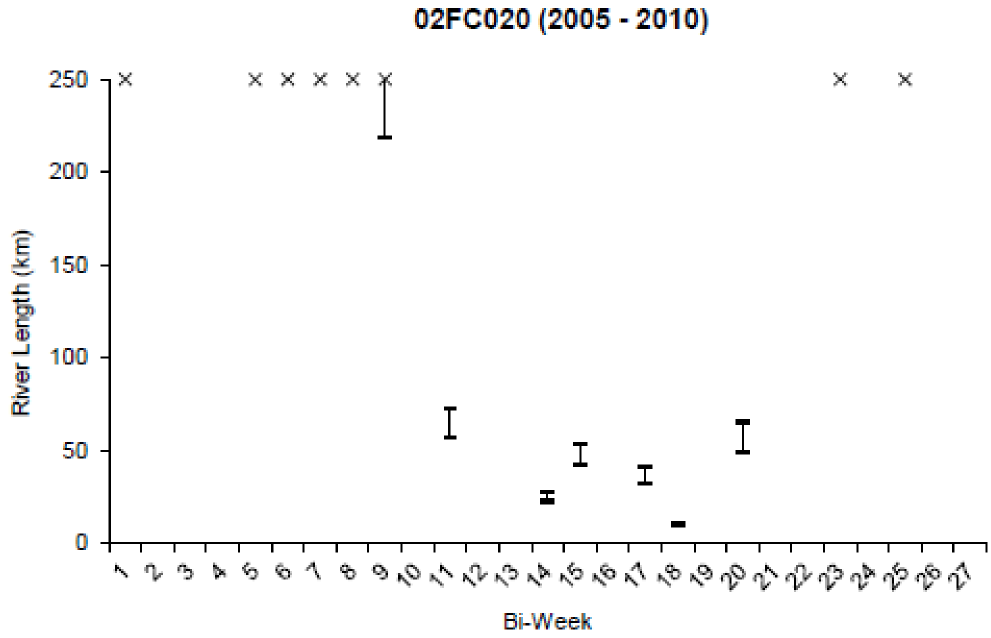


Figure A1-73. Gauging station 02FC018 data from 1986–1992. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



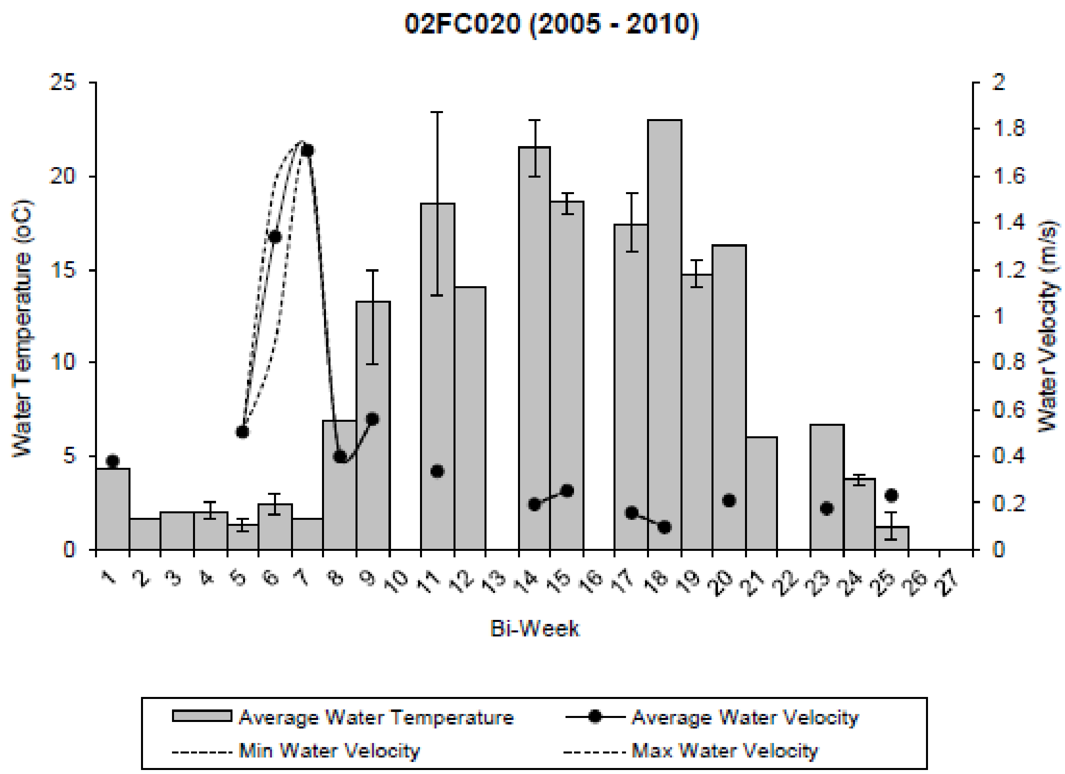
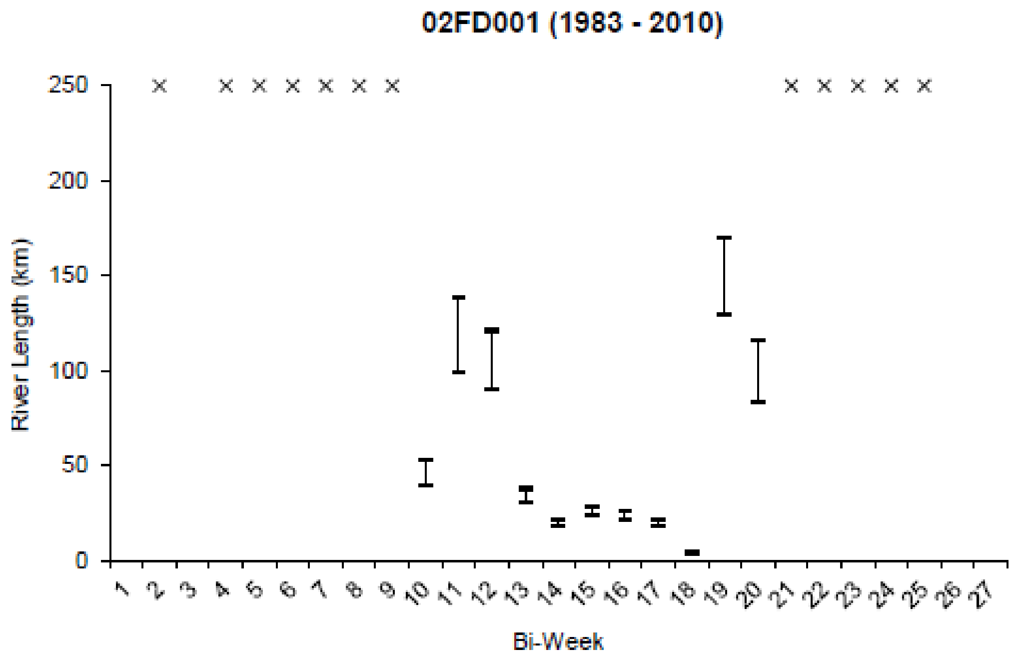


Figure A1-74. Gauging station 02FC020 data from 2005–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



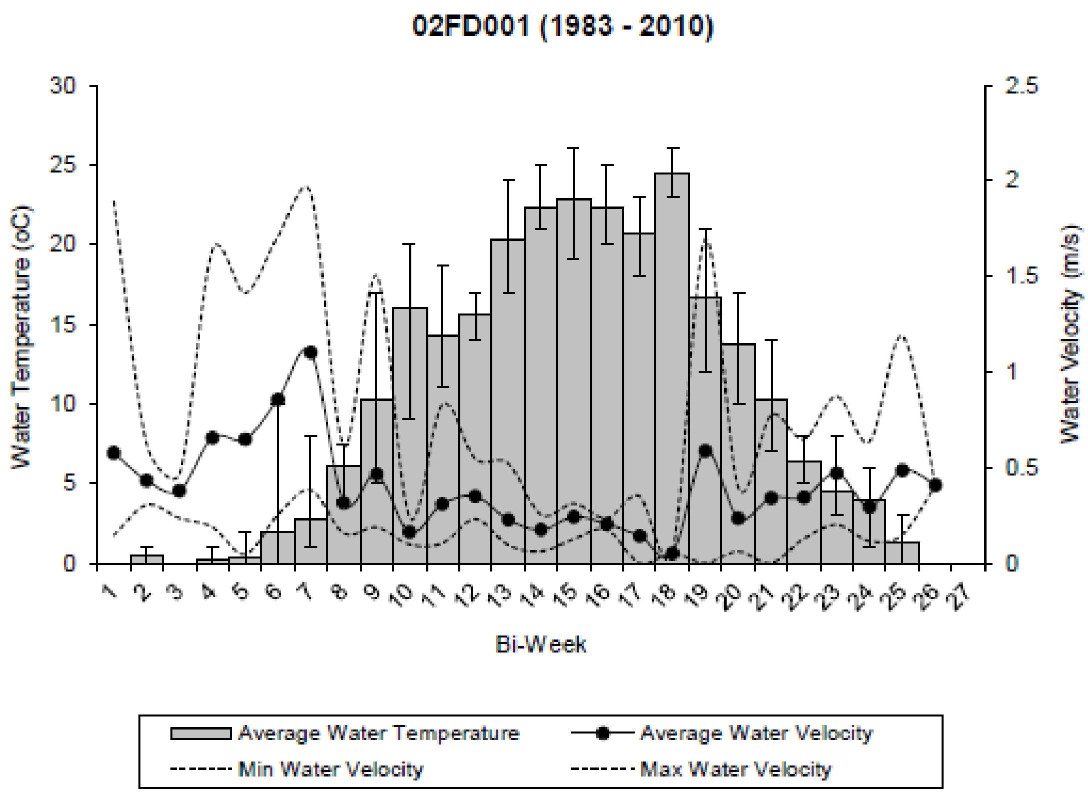
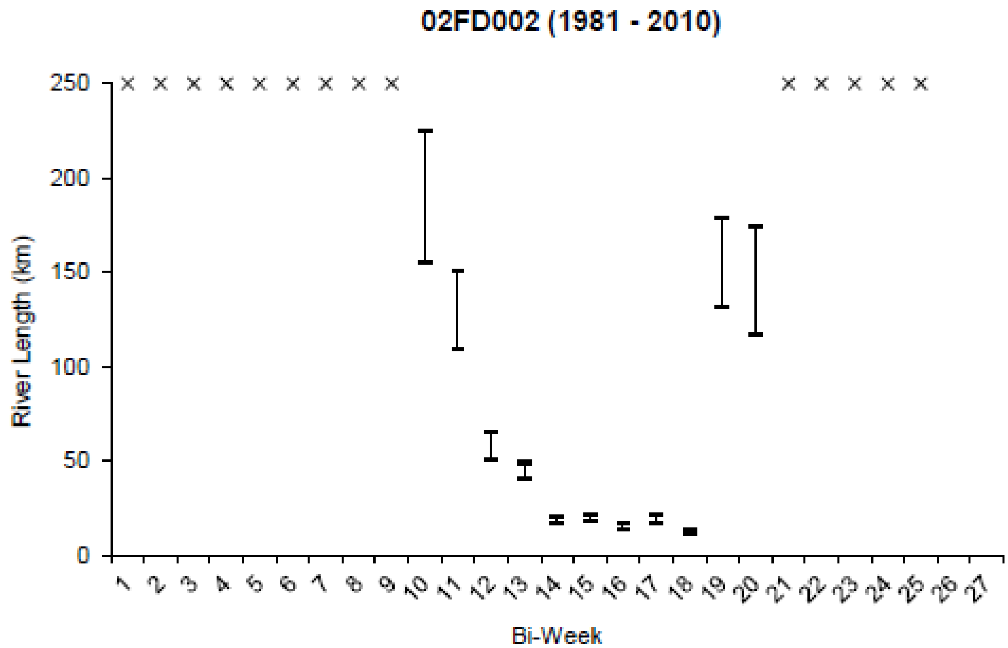


Figure A1-75. Gauging station 02FD001 data from 1983–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



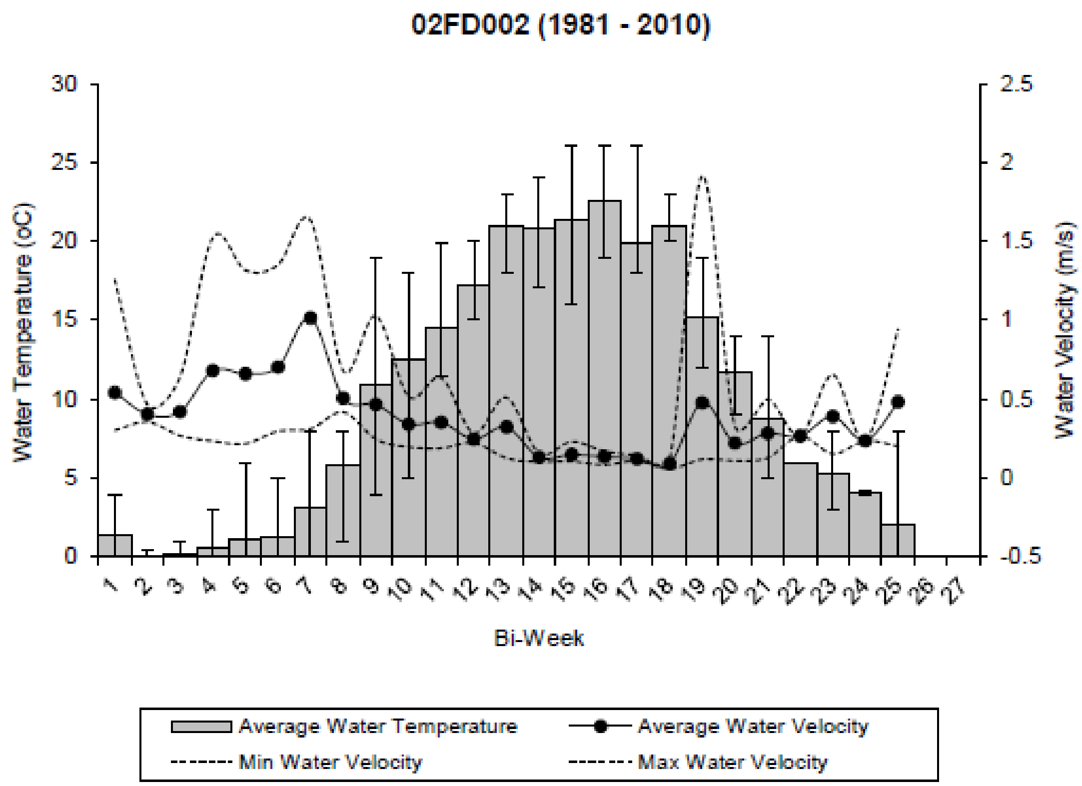


Figure A1-76. Gauging station 02FD002 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

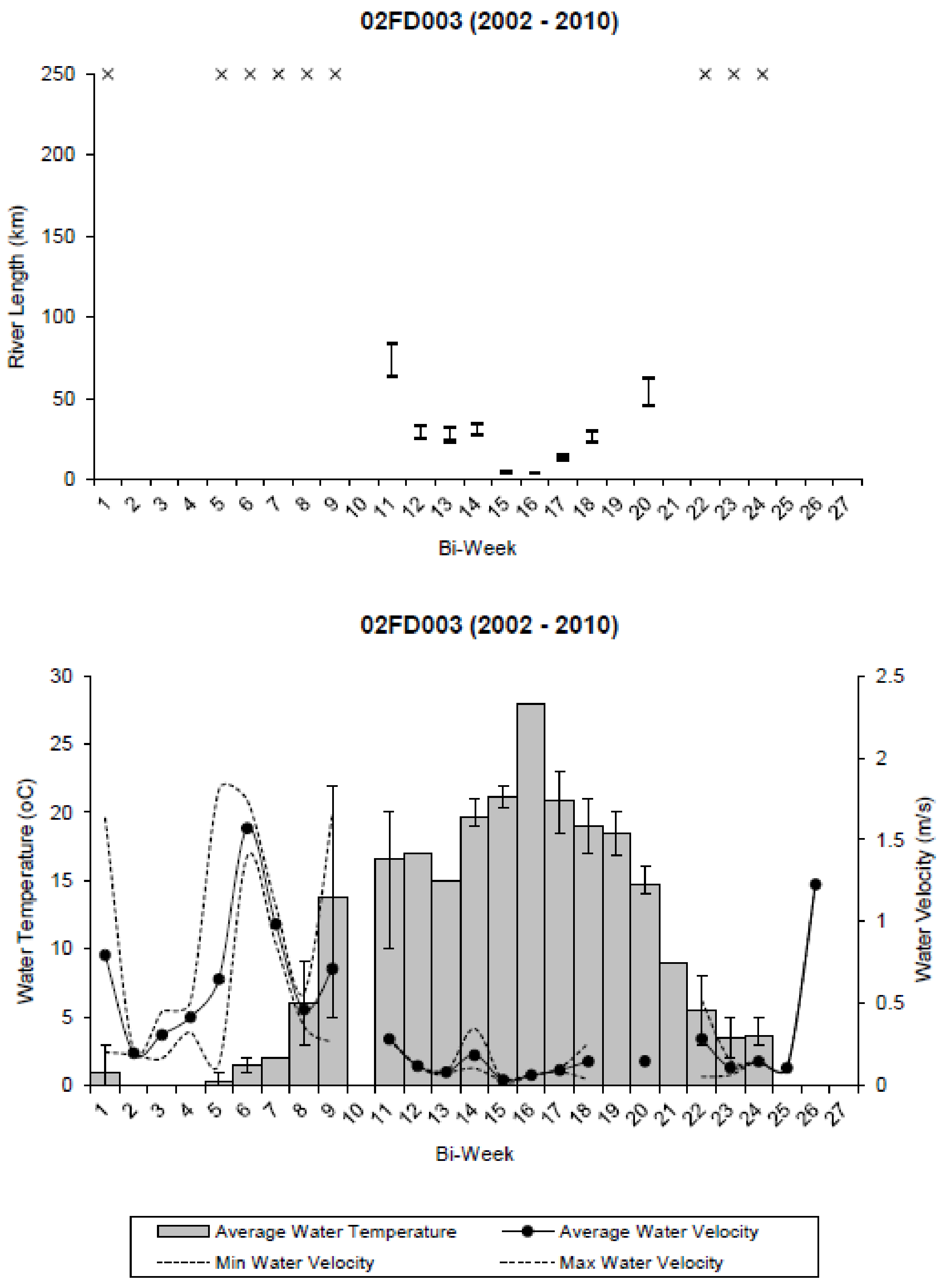
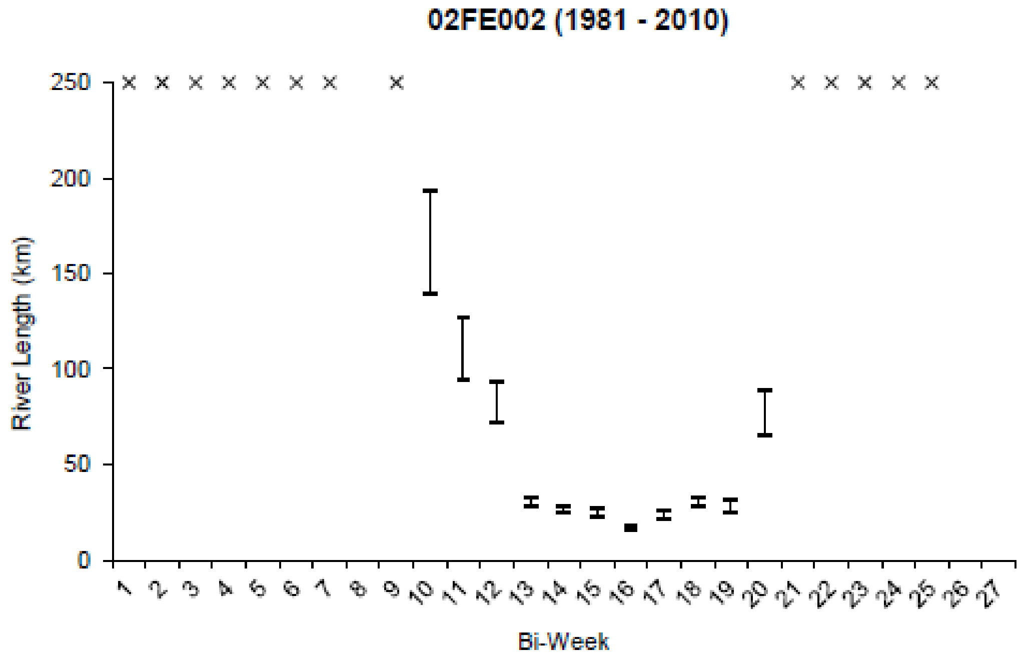


Figure A1-77. Gauging station 02FD003 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



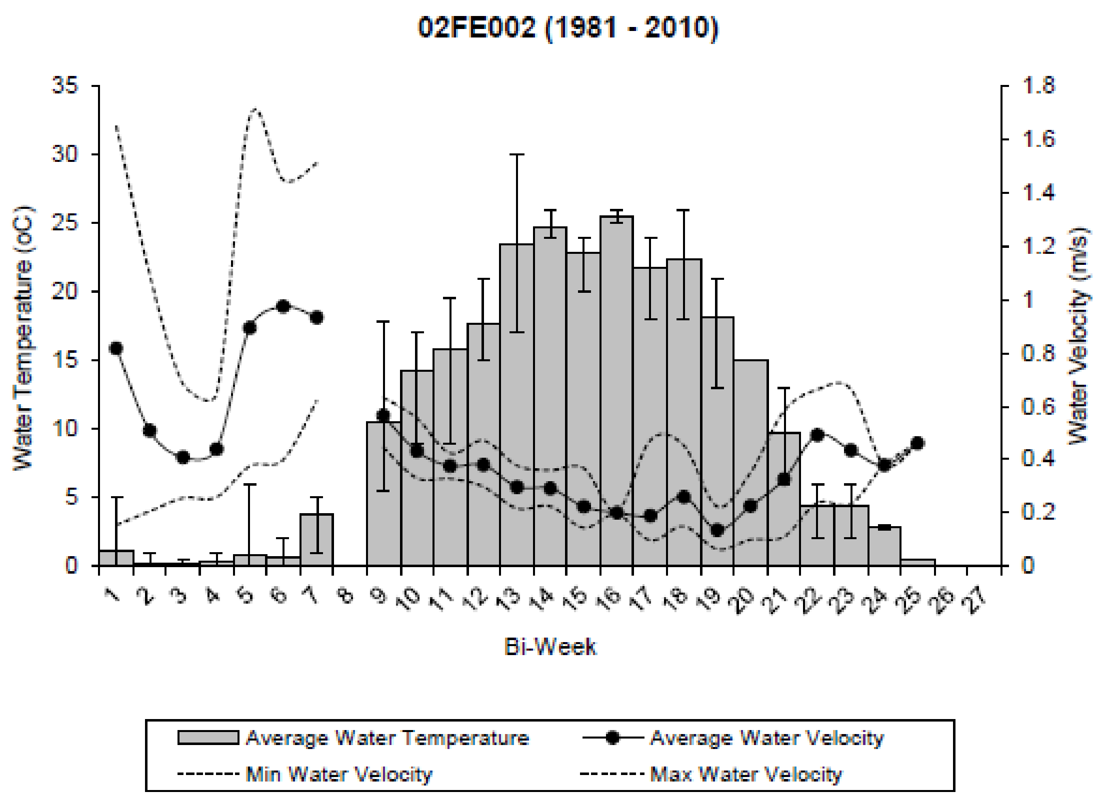
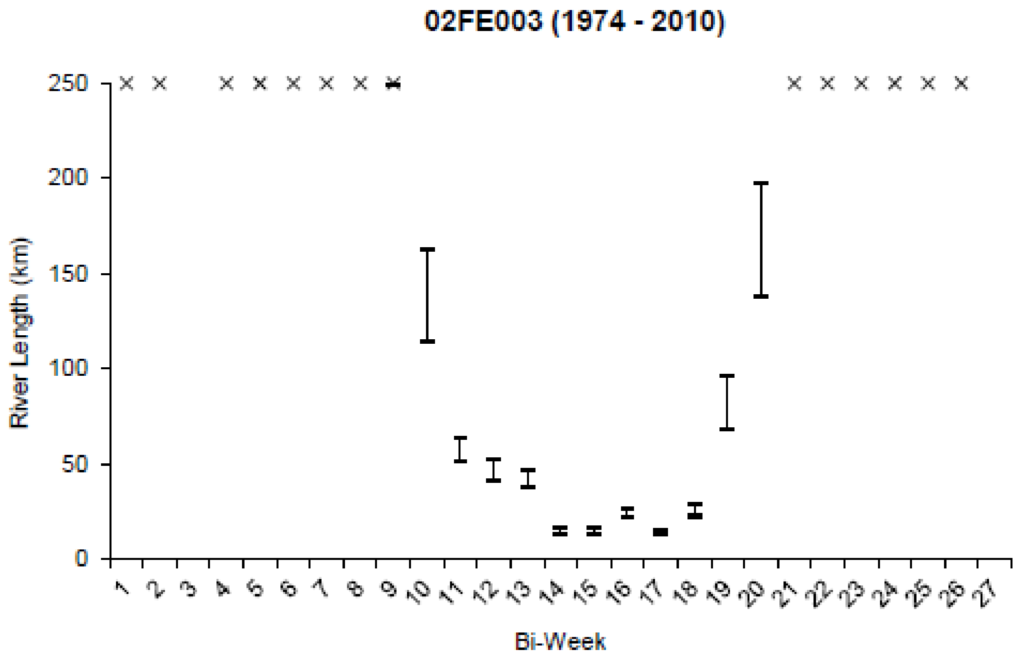


Figure A1-78. Gauging station 02FE002 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



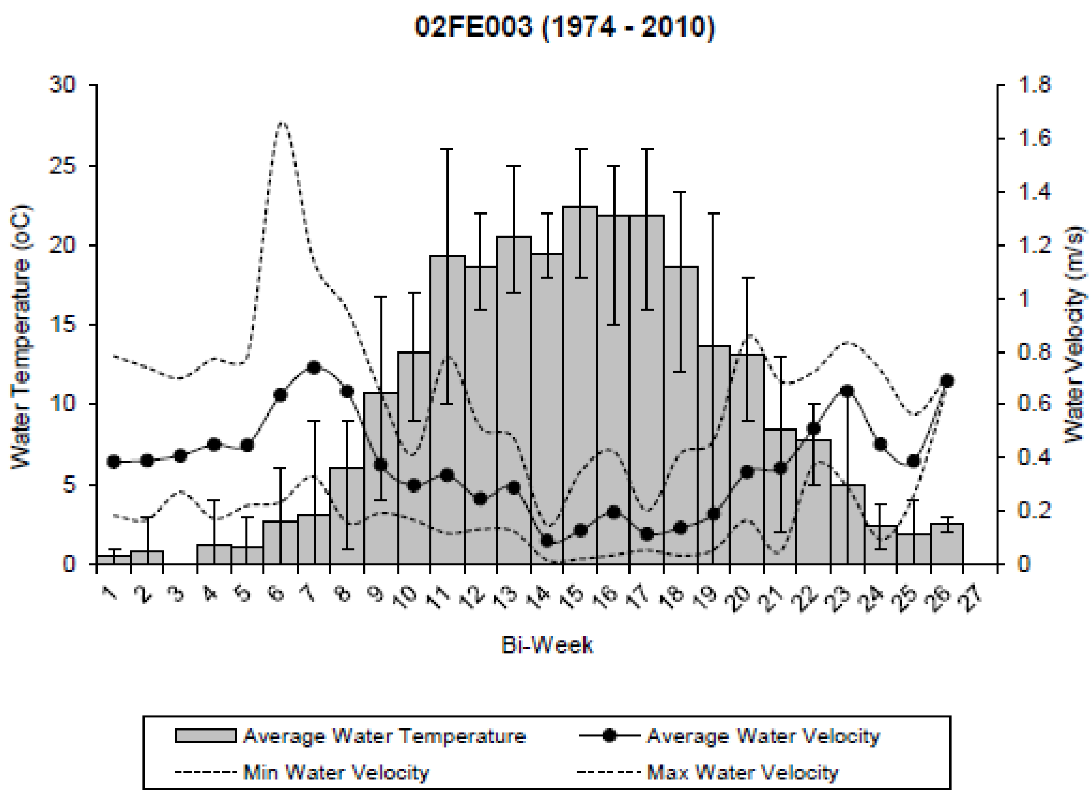
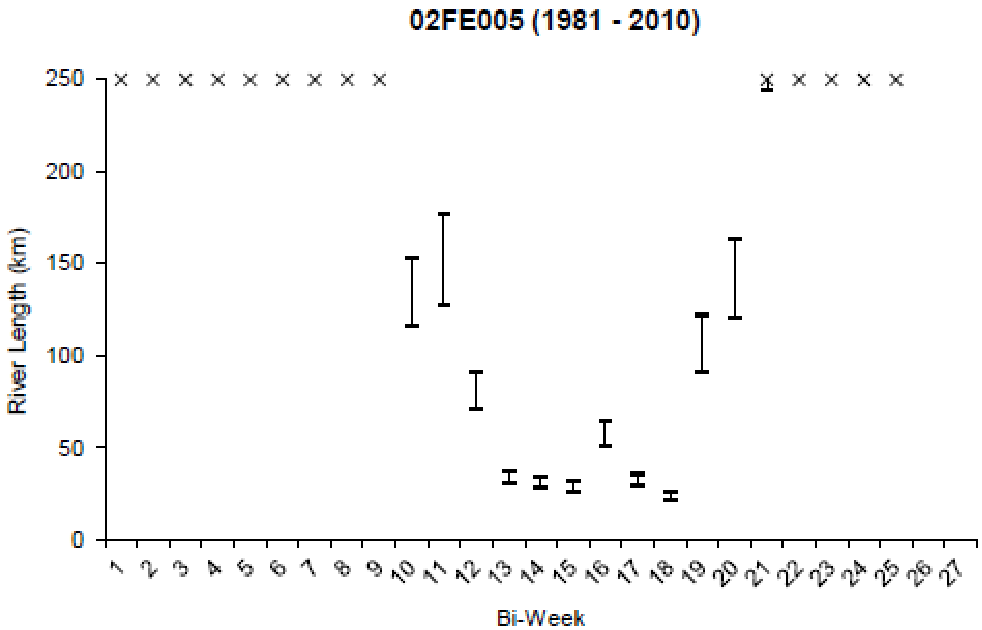


Figure A1-79. Gauging station 02FE003 data from 1974–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



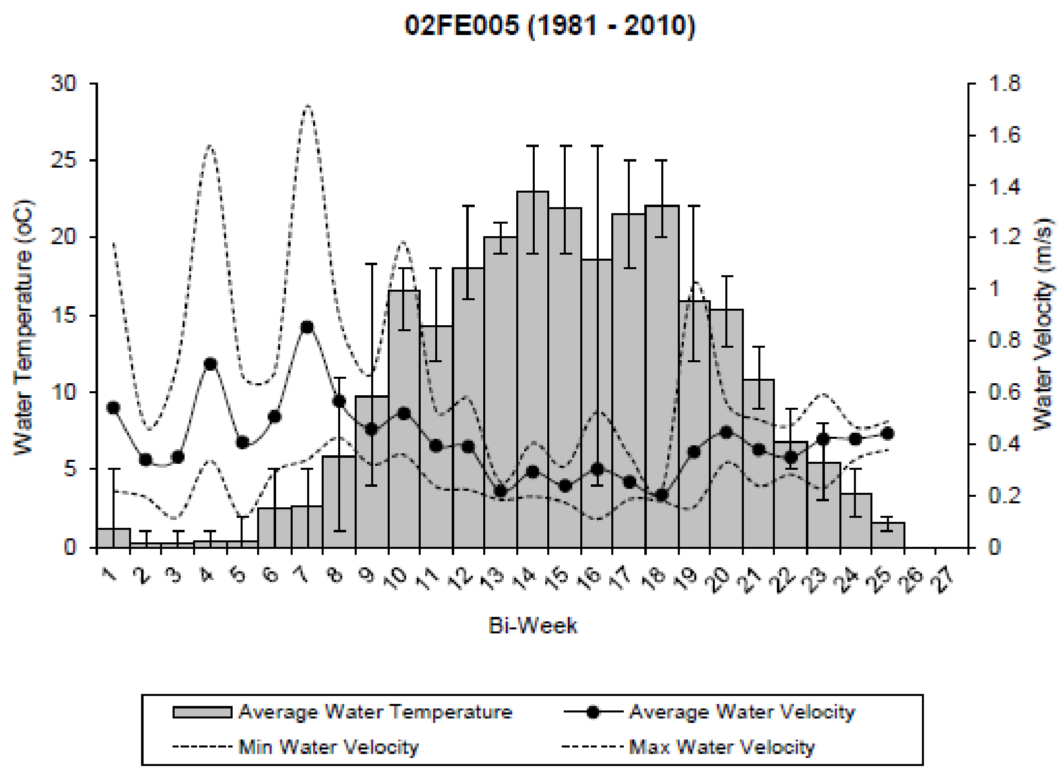
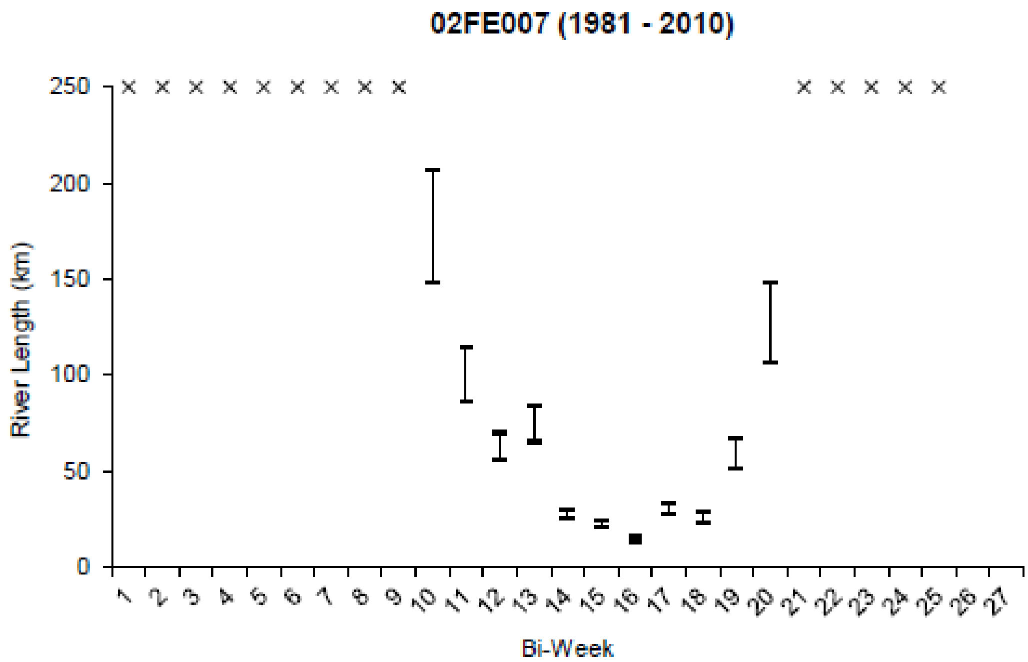


Figure A1-80. Gauging station 02FE005 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



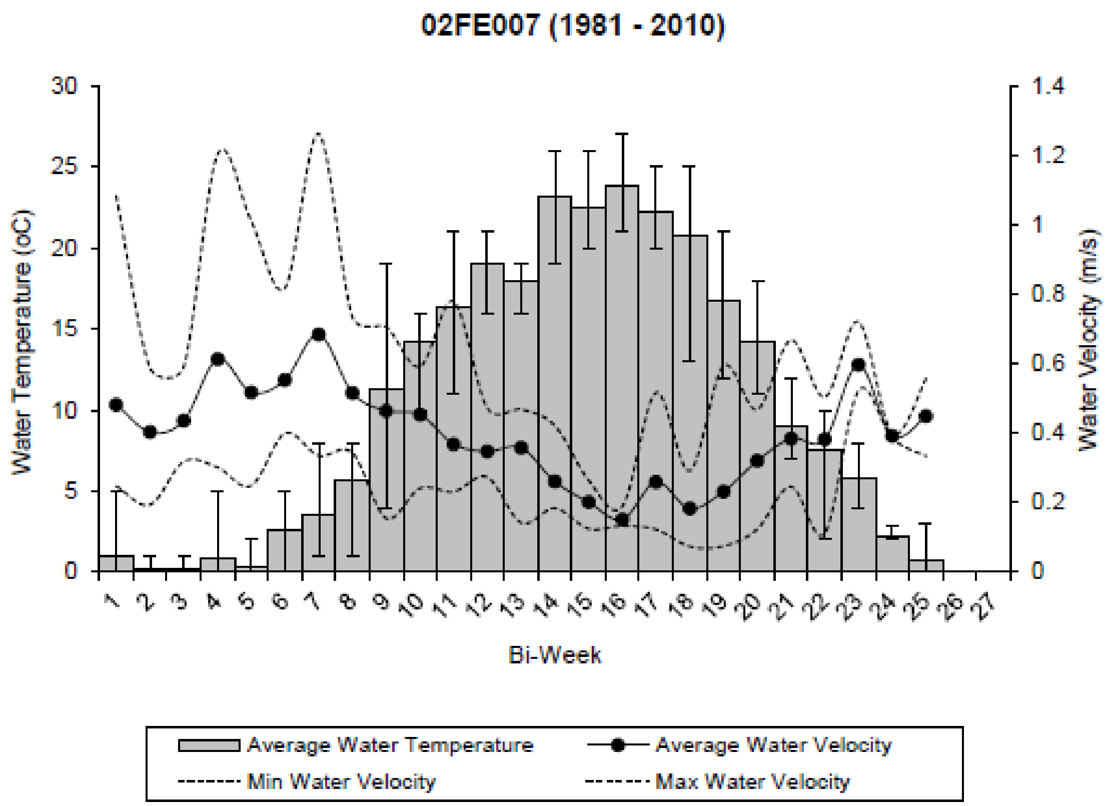
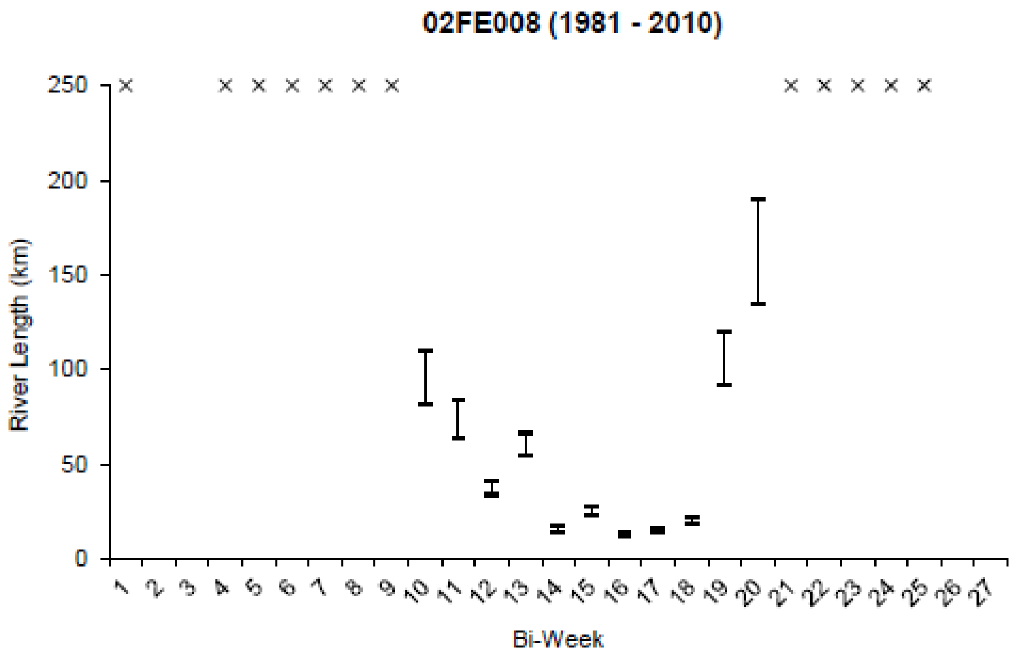


Figure A1-81. Gauging station 02FE007 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



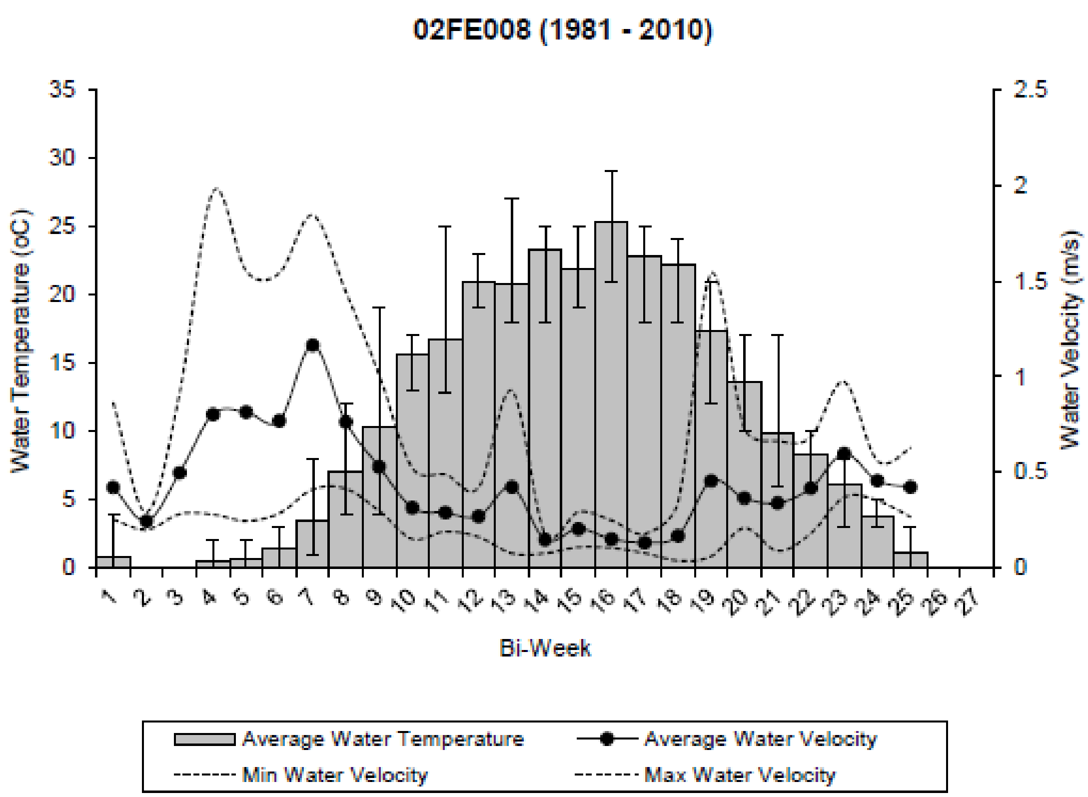
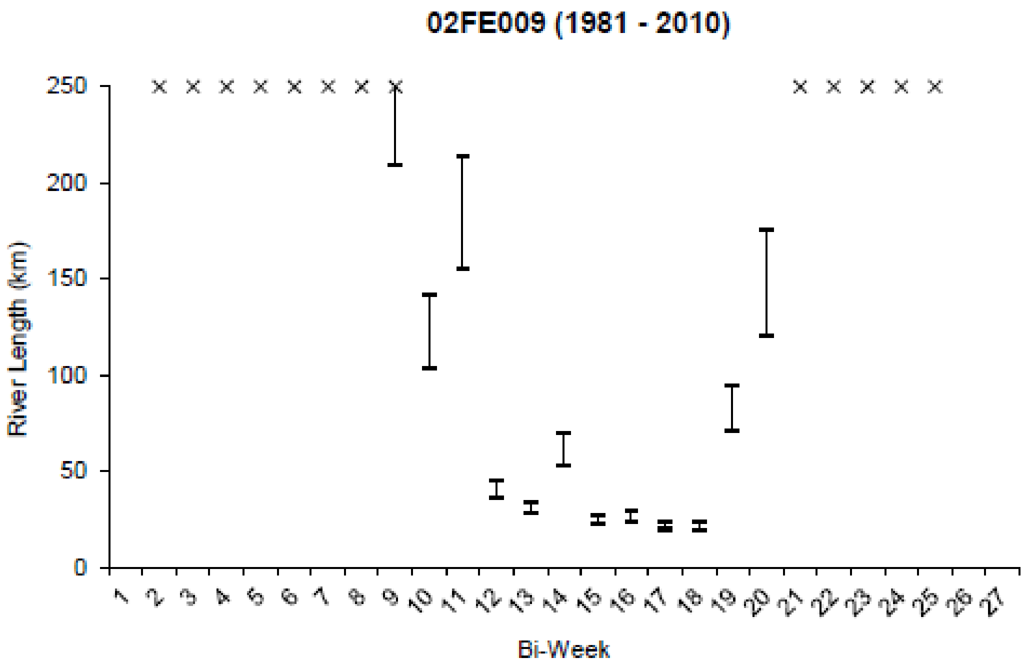


Figure A1-82. Gauging station 02FE008 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



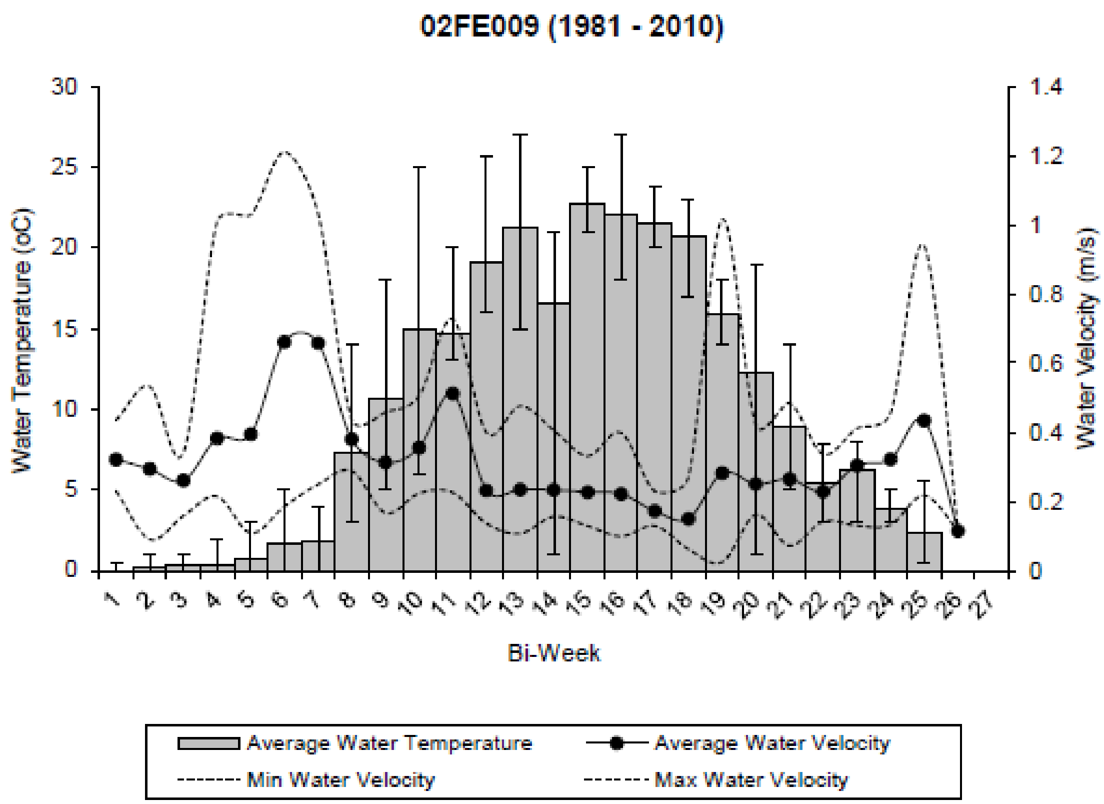
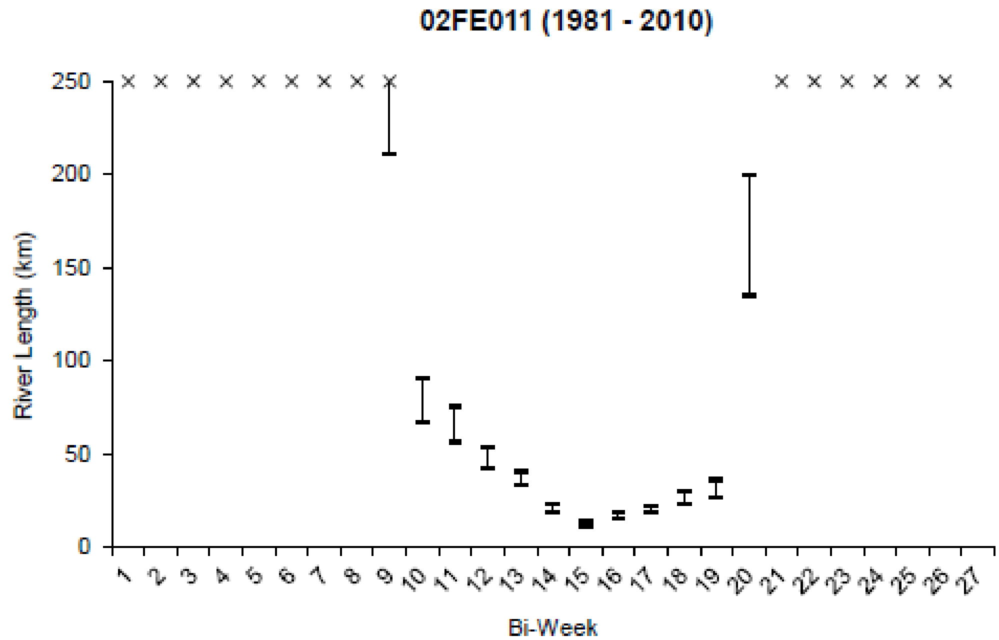


Figure A1-83. Gauging station 02FE009 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



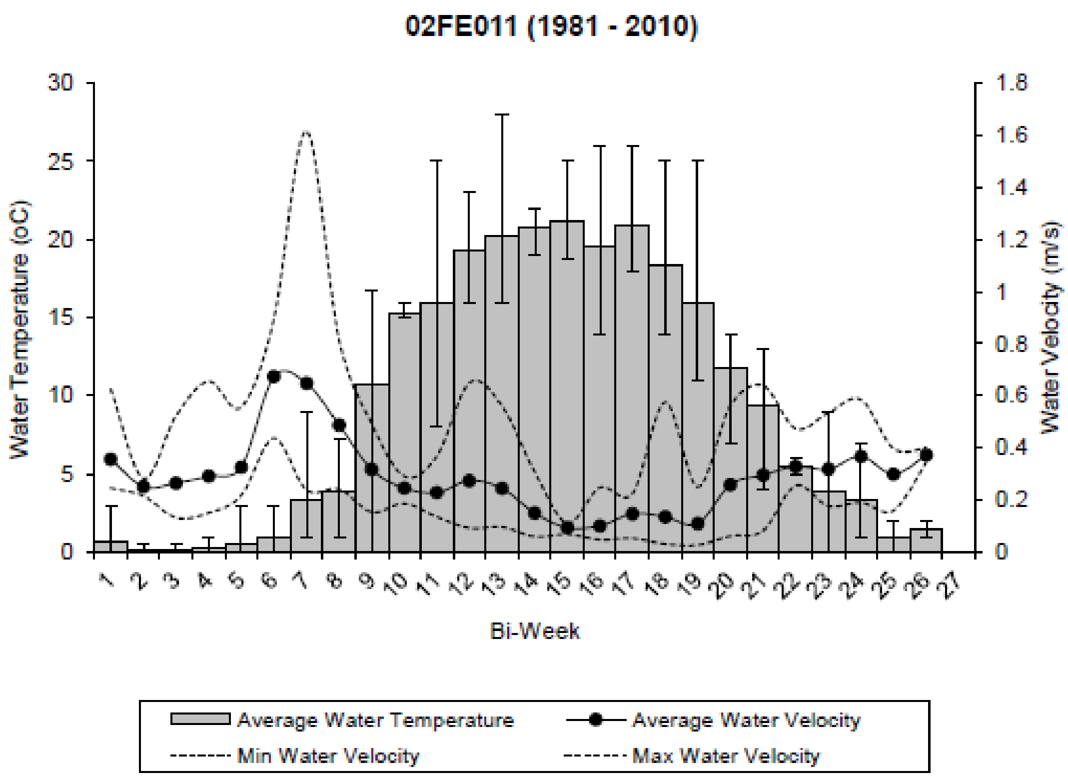
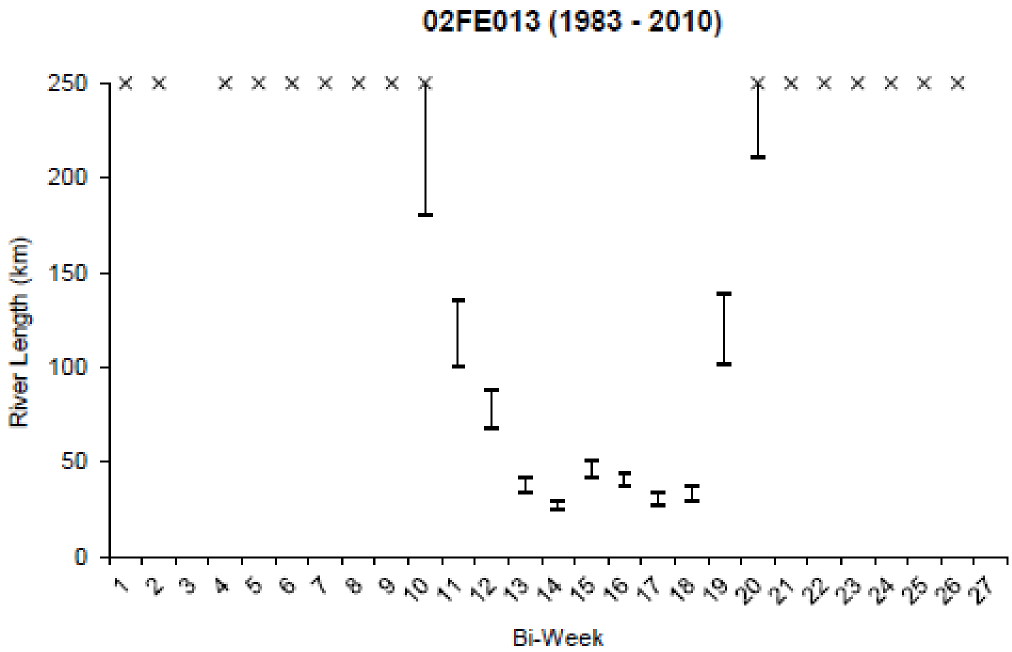


Figure A1-84. Gauging station 02FE011 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



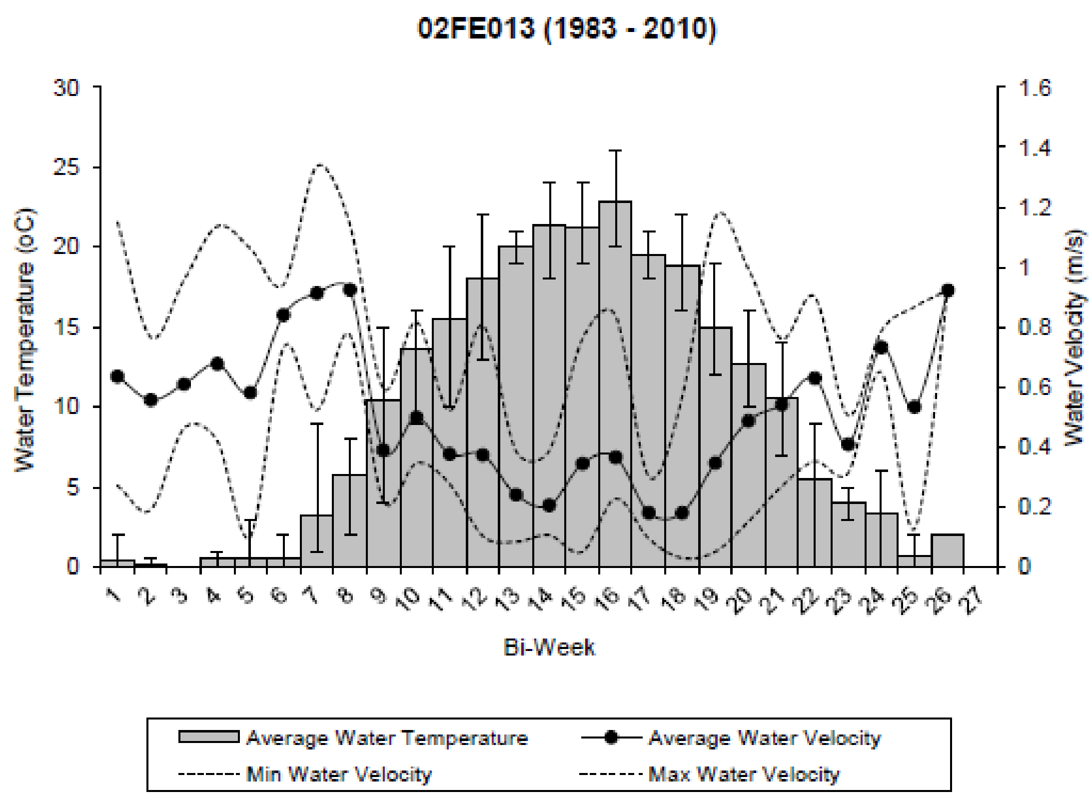
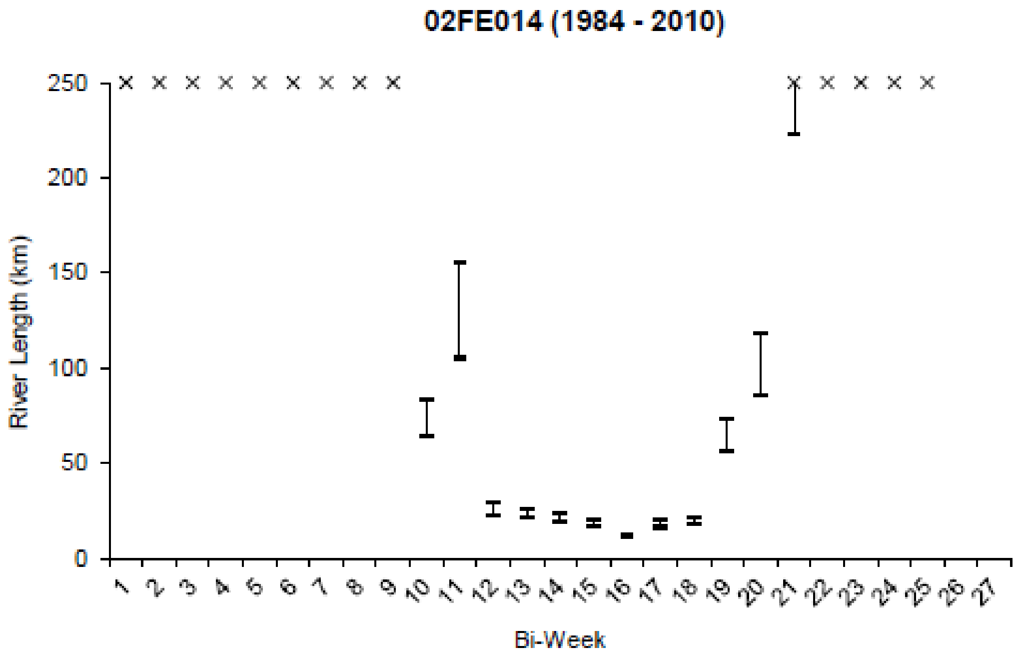


Figure A1-85. Gauging station 02FE013 data from 1983–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



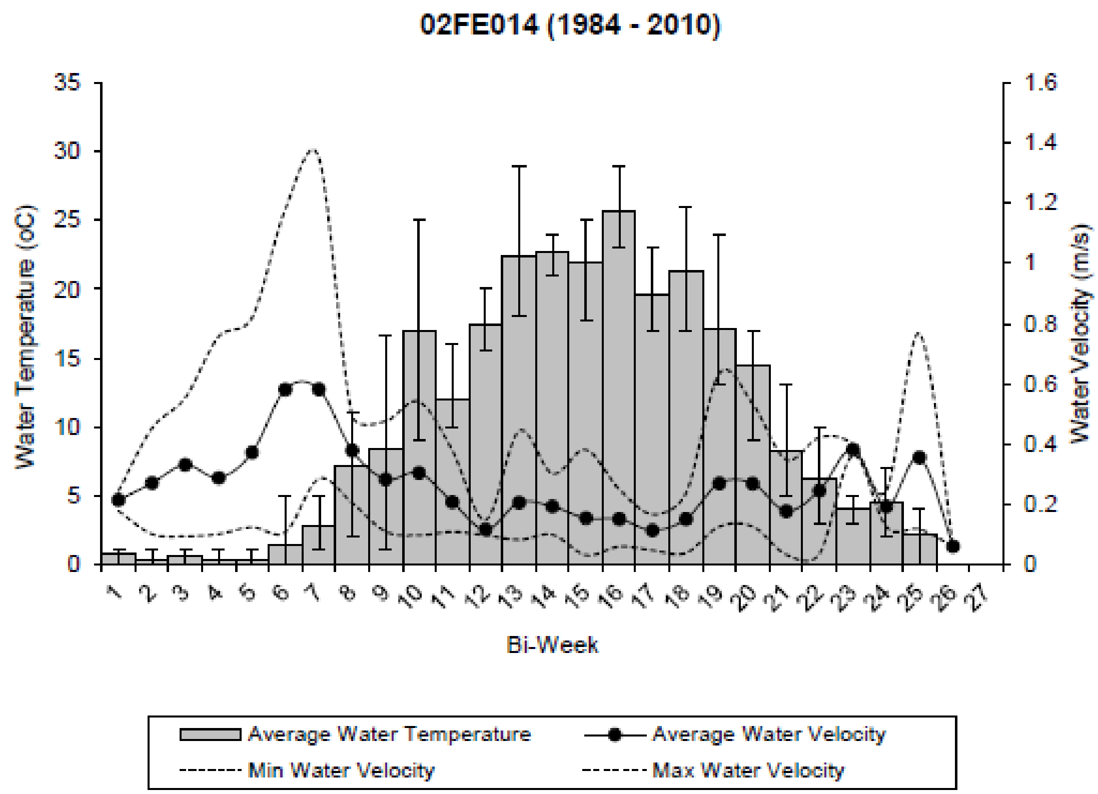
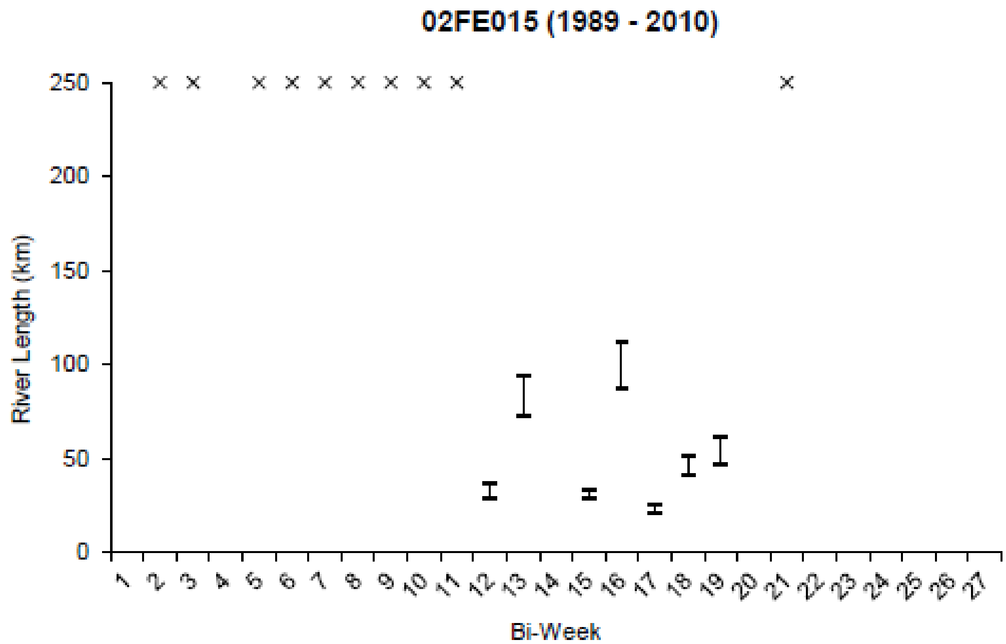


Figure A1-86. Gauging station 02FE014 data from 1984–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



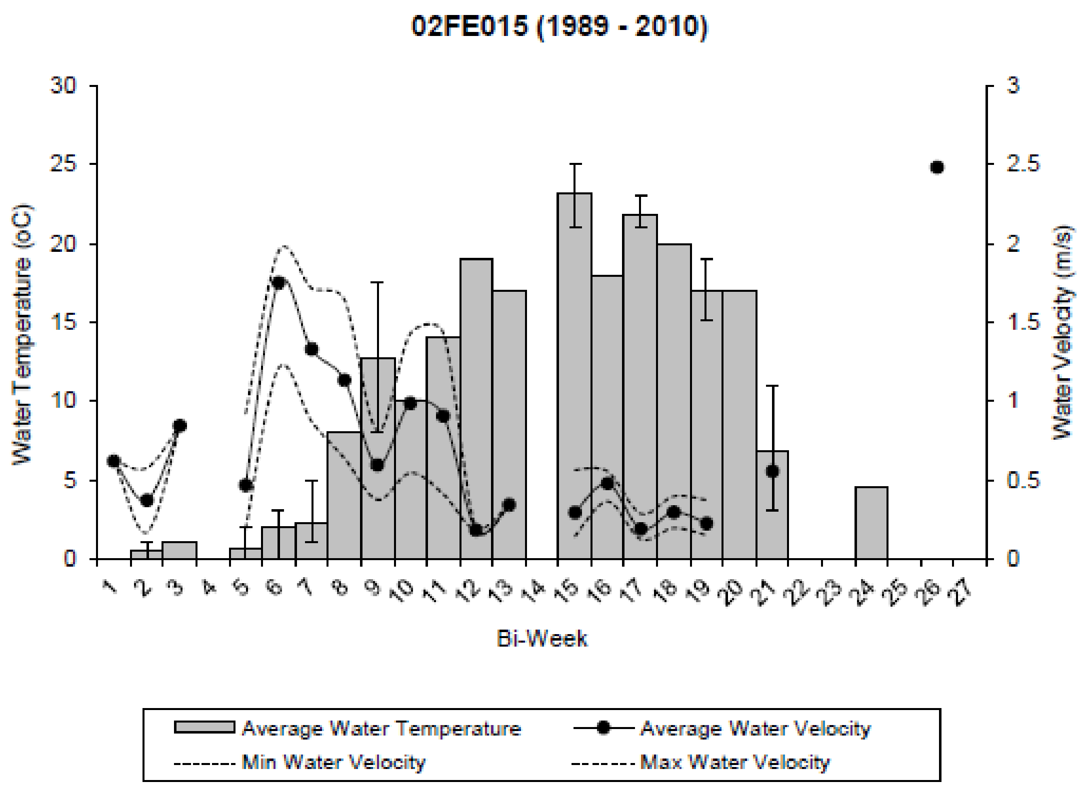


Figure A1-87. Gauging station 02FE015 data from 1989–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

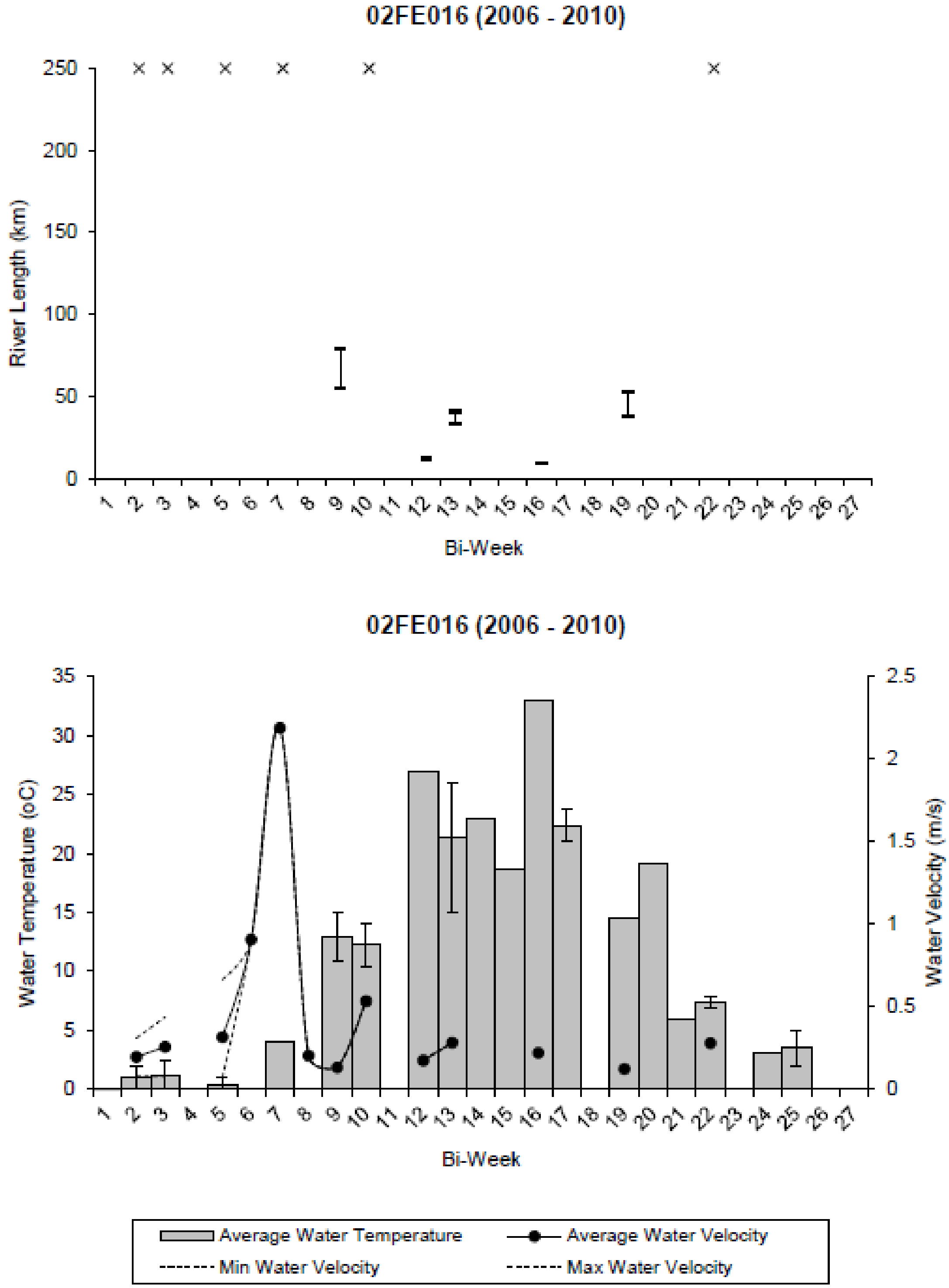
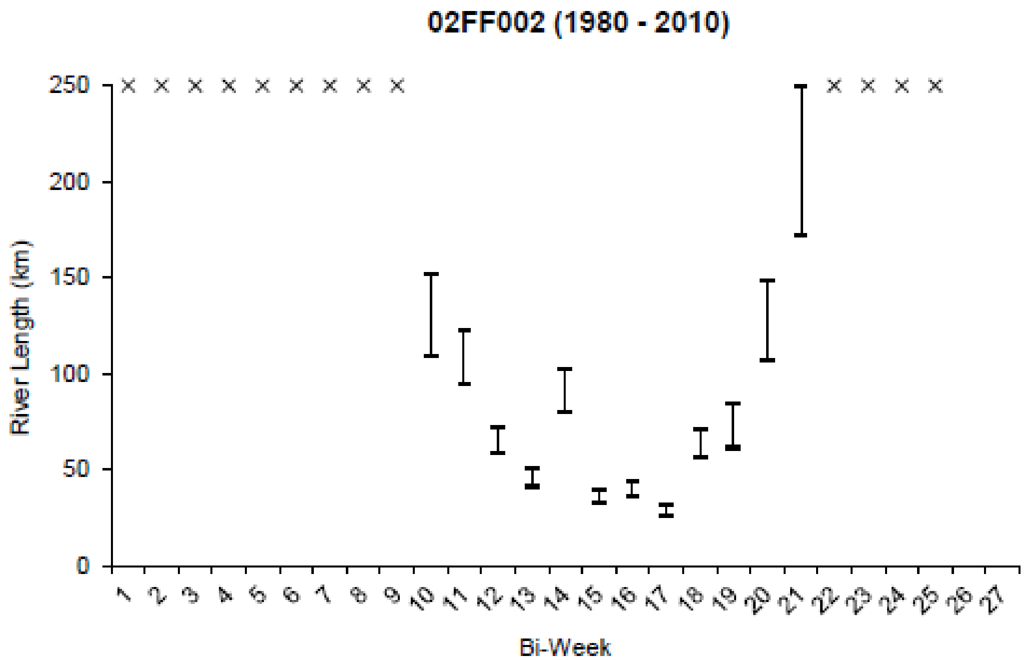


Figure A1-88. Gauging station 02FE016 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



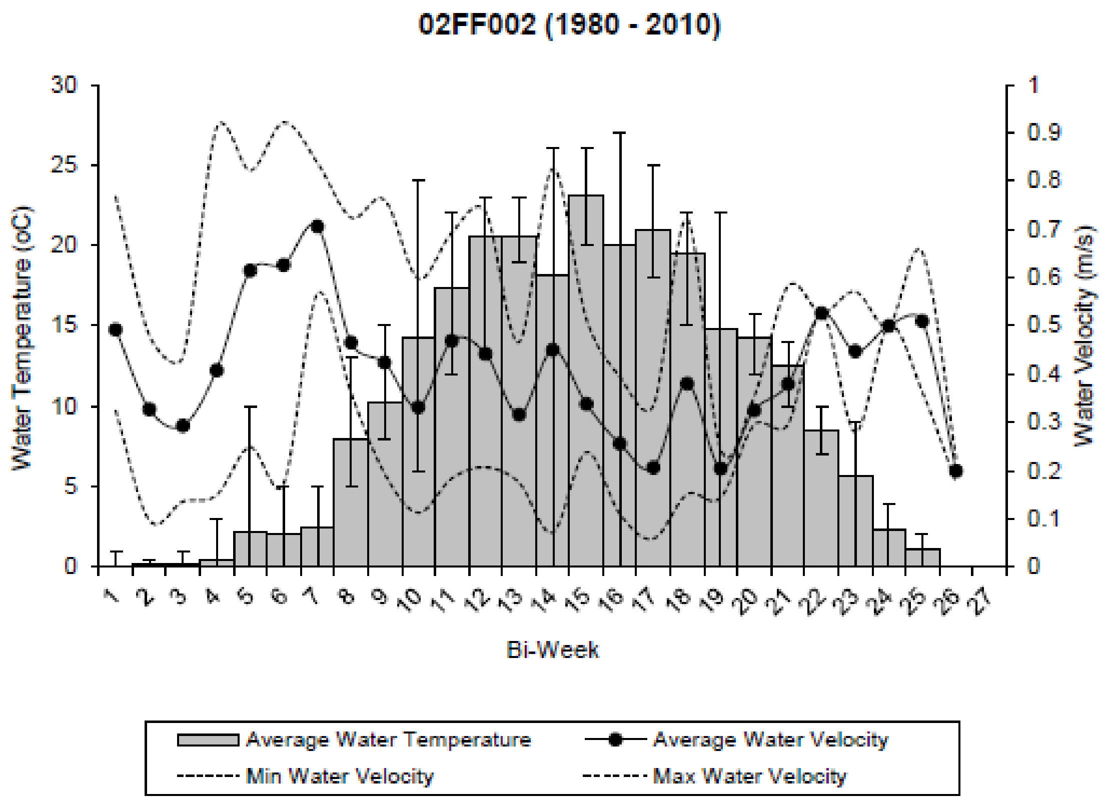
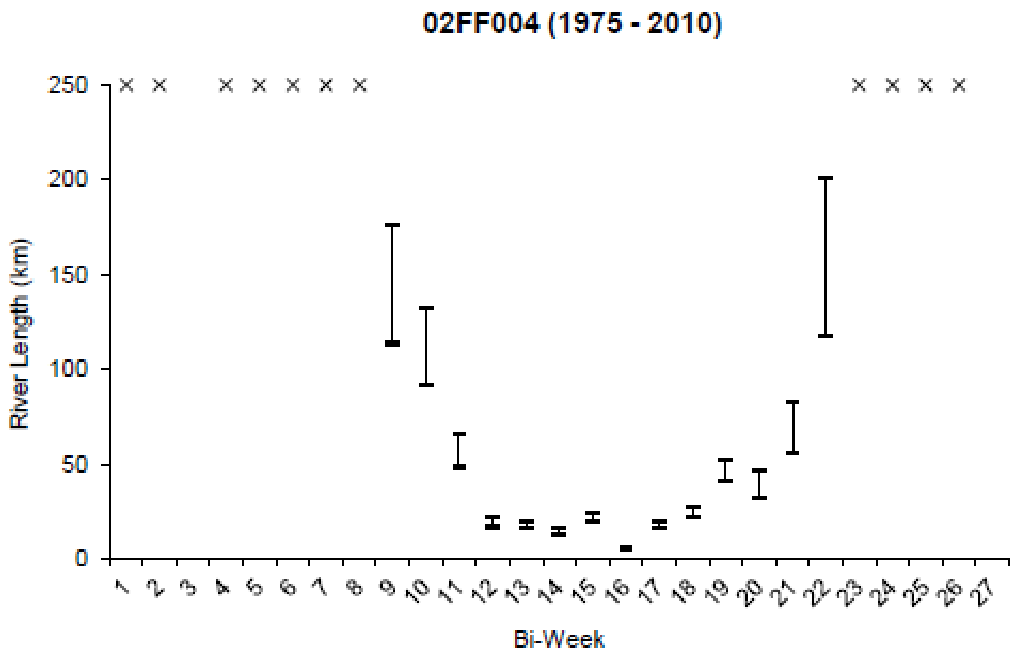


Figure A1-89. Gauging station 02FF002 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



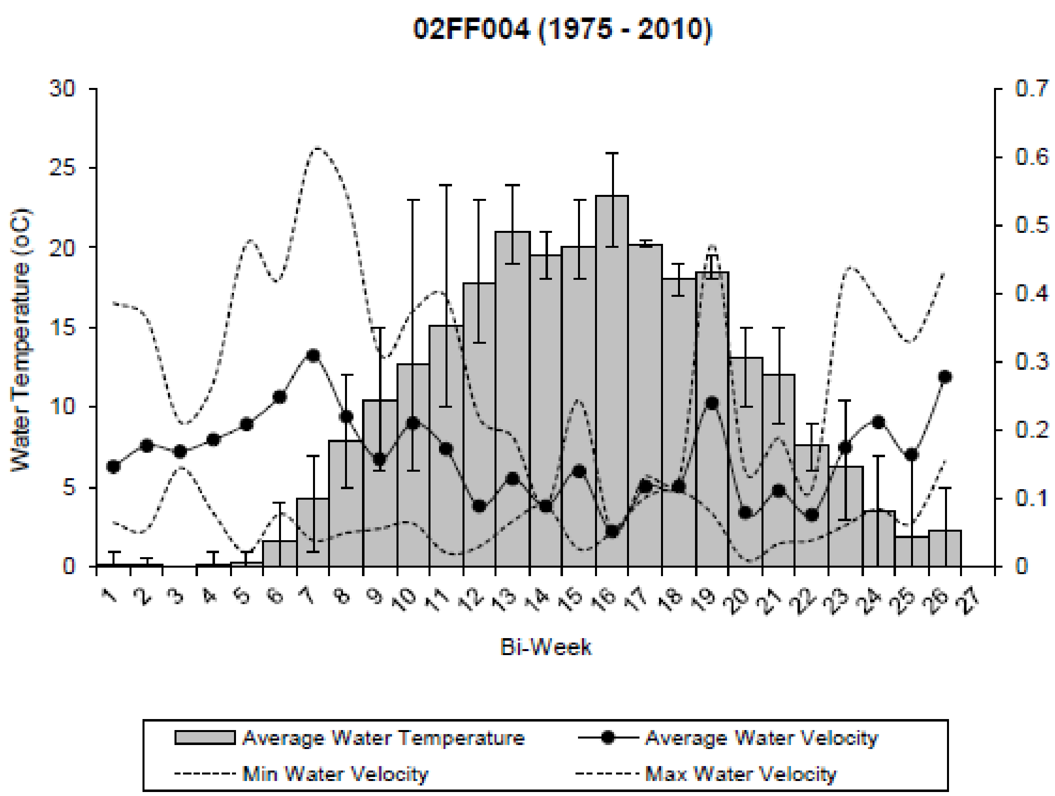
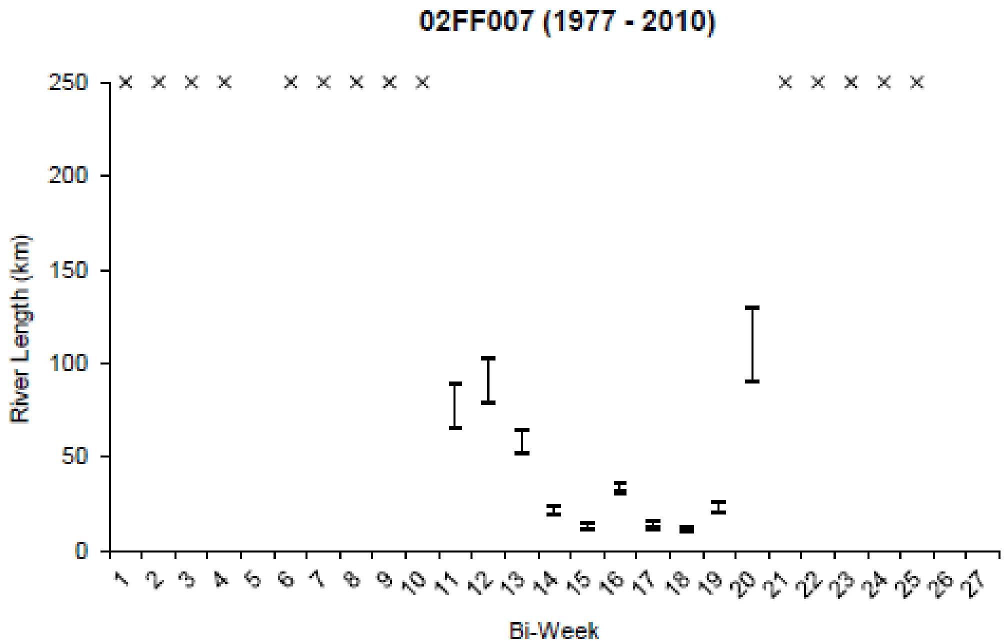


Figure A1-90. Gauging station 02FF004 data from 1975–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



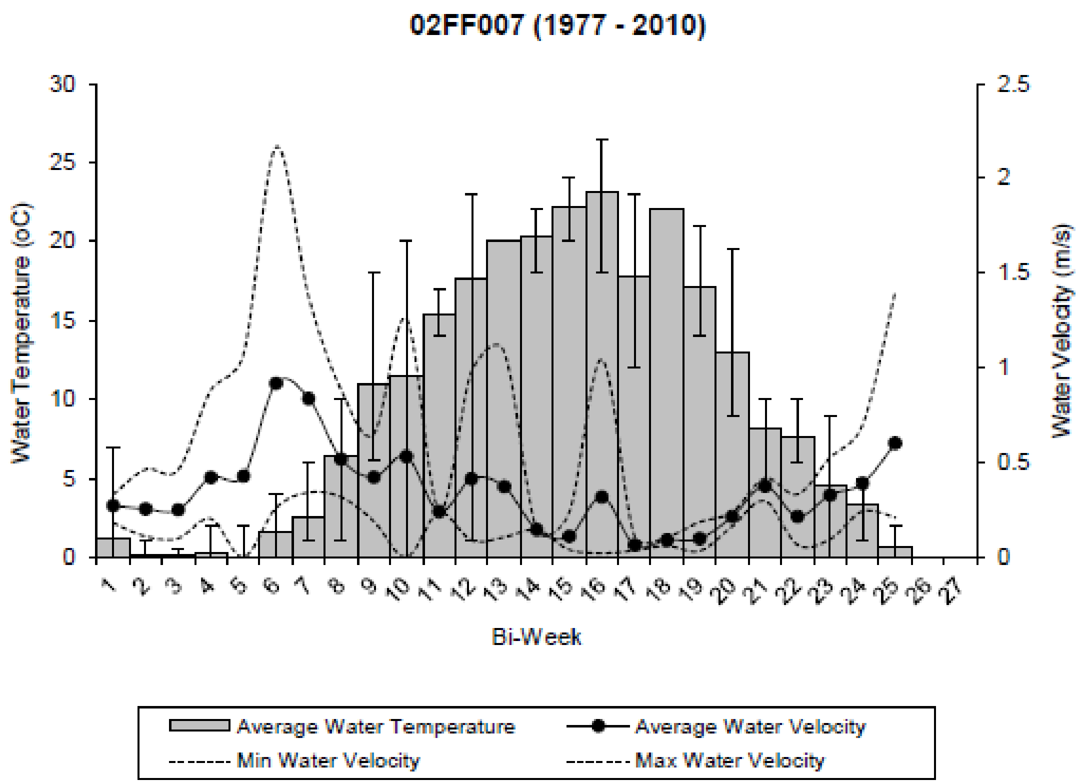
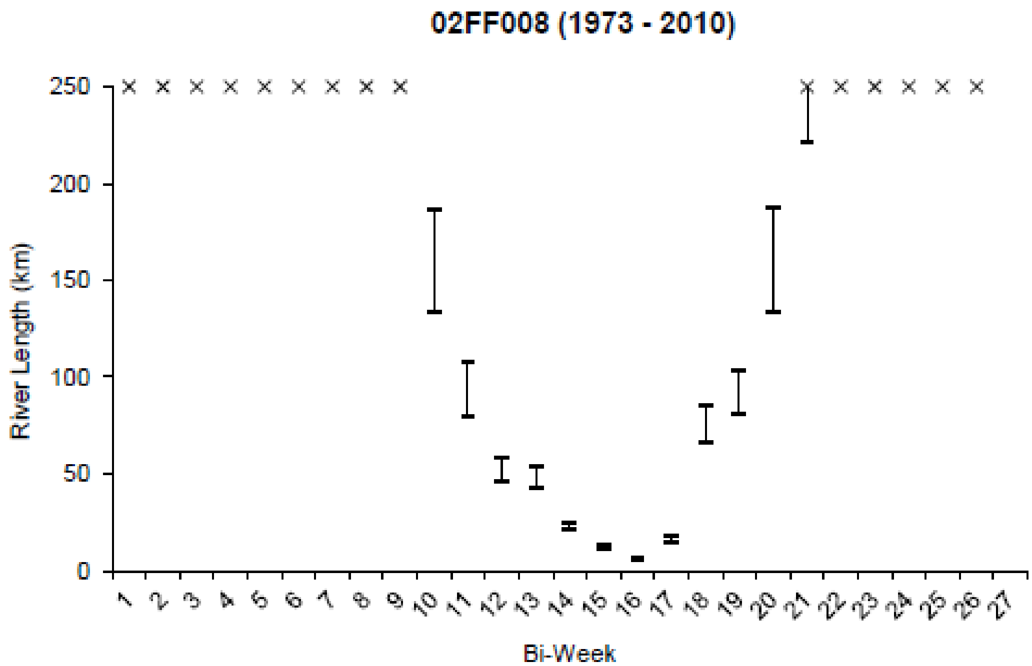


Figure A1-91. Gauging station 02FF007 data from 1977–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



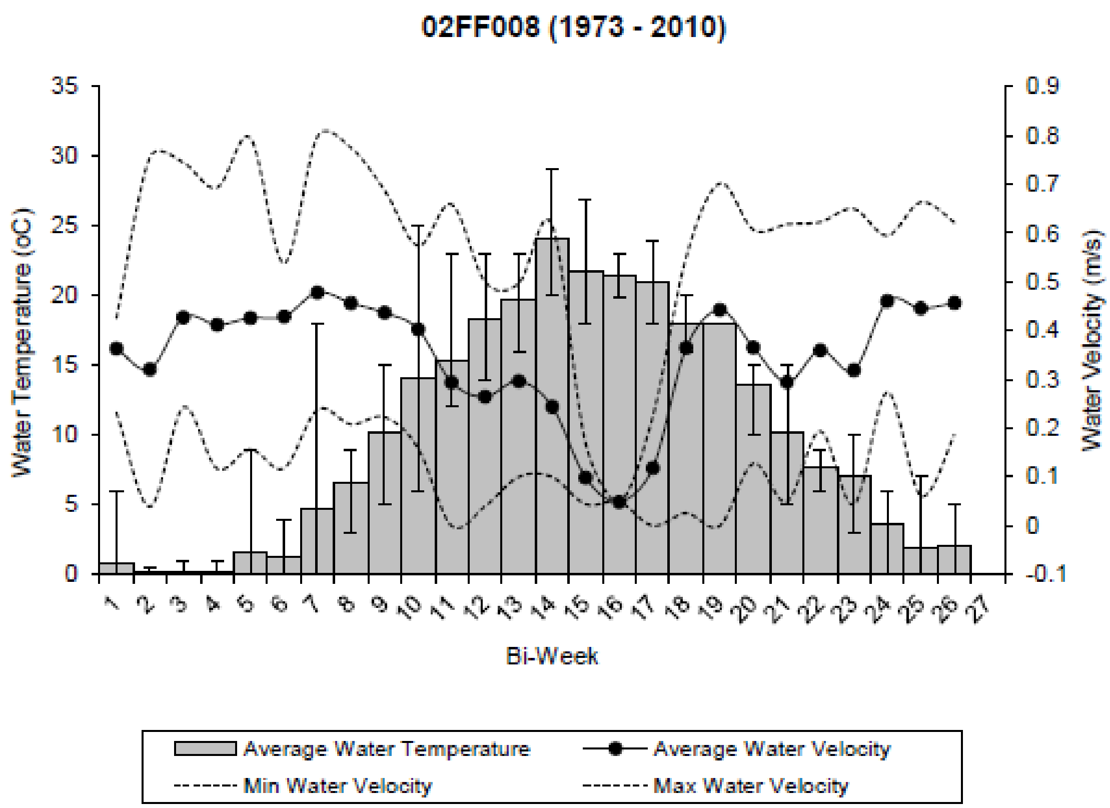


Figure A1-92. Gauging station 02FF008 data from 1973–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

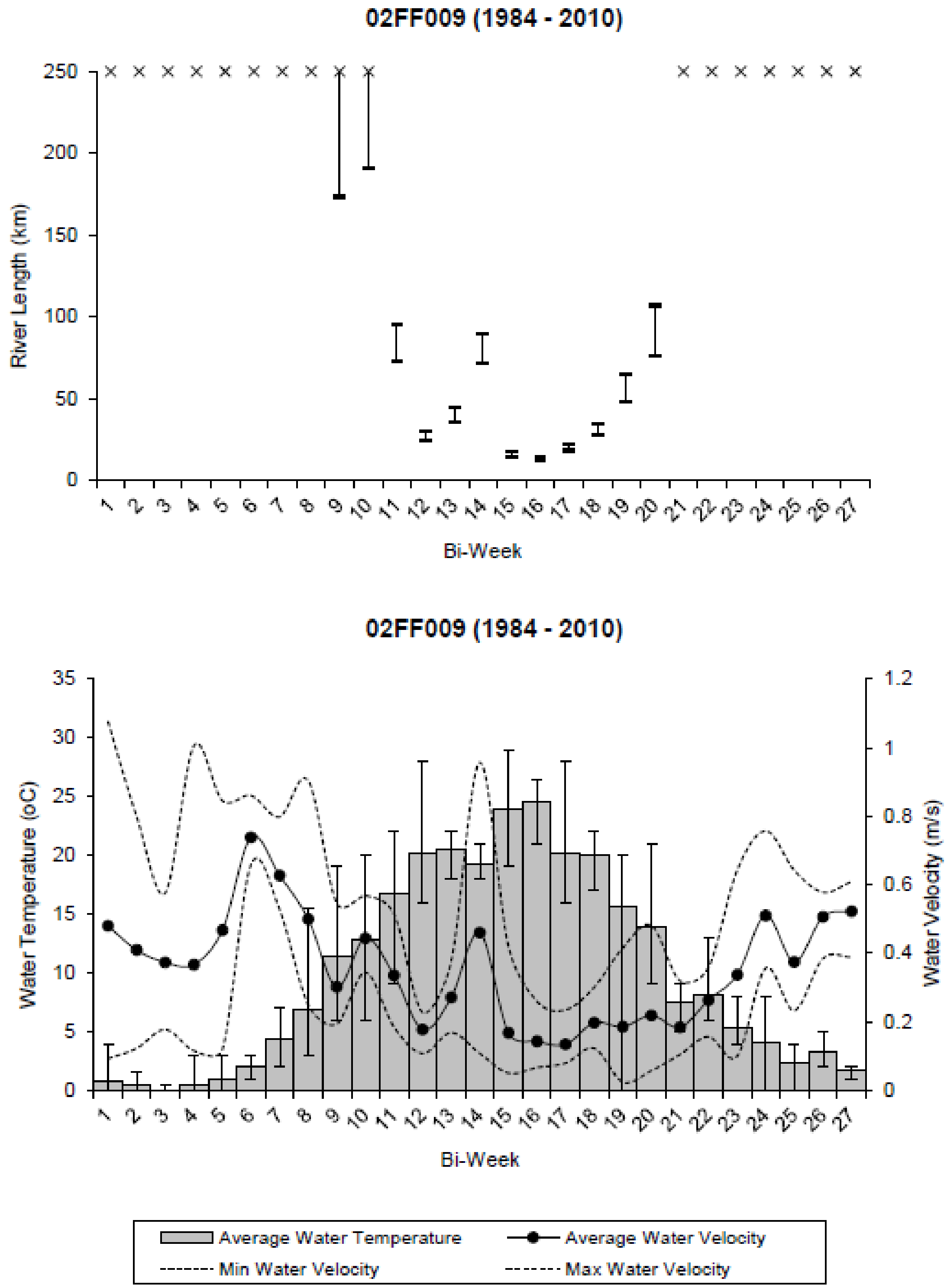
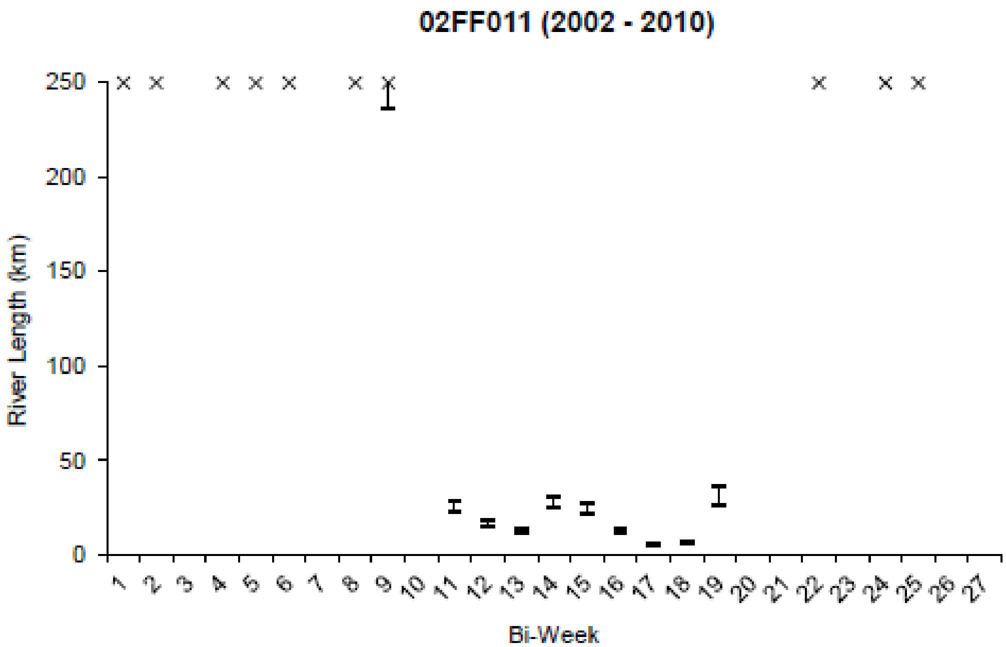


Figure A1-93. Gauging station 02FF009 data from 1984–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



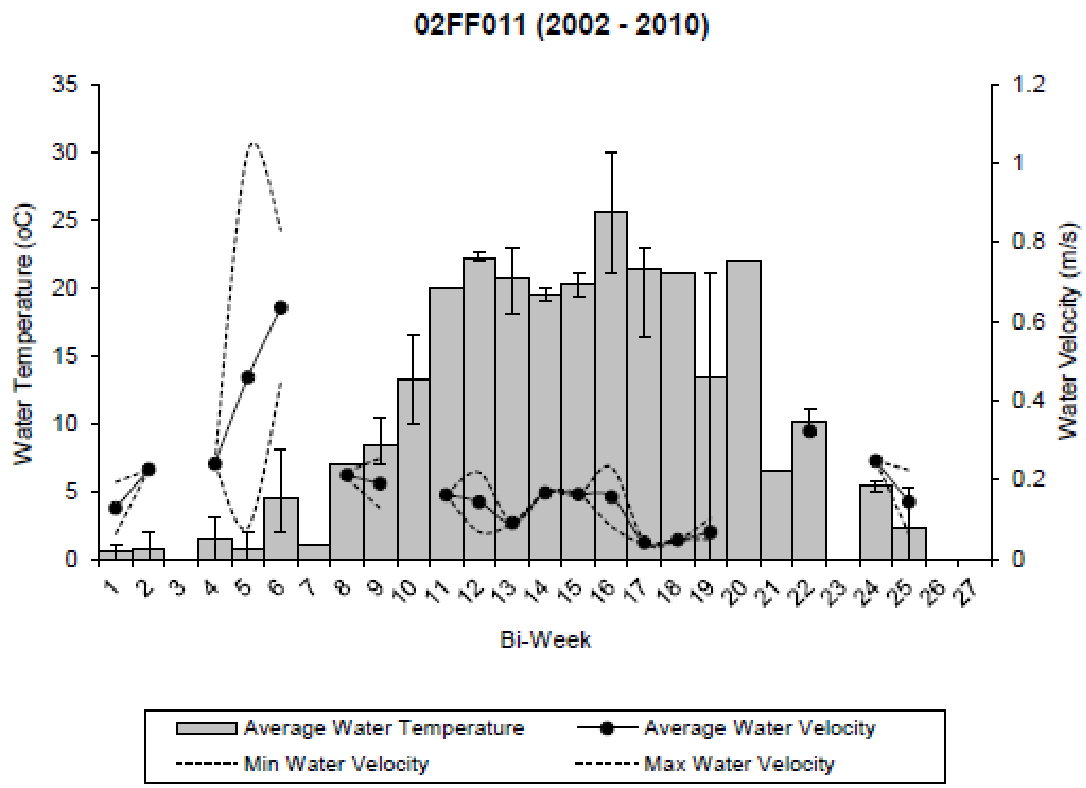


Figure A1-94. Gauging station 02FF011 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

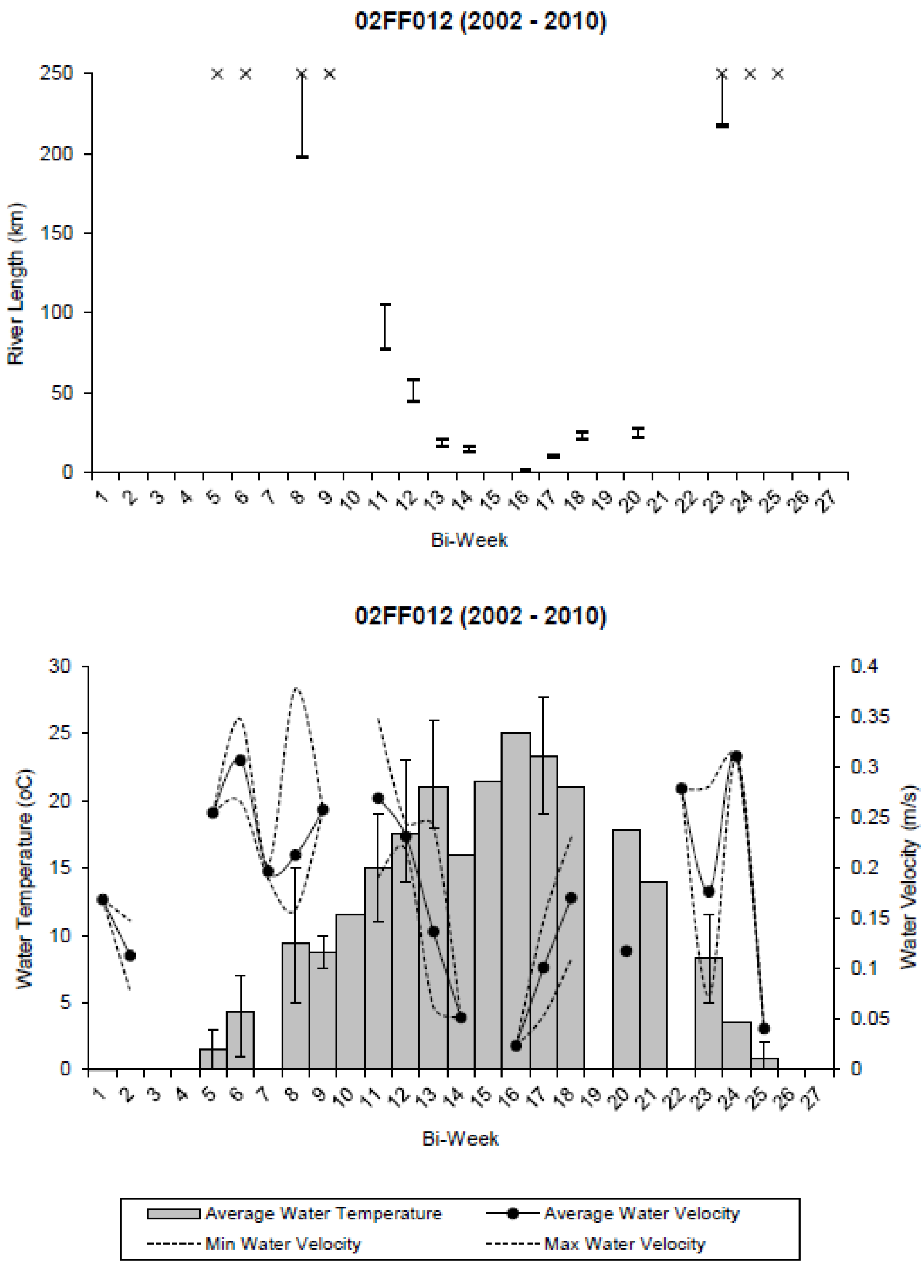
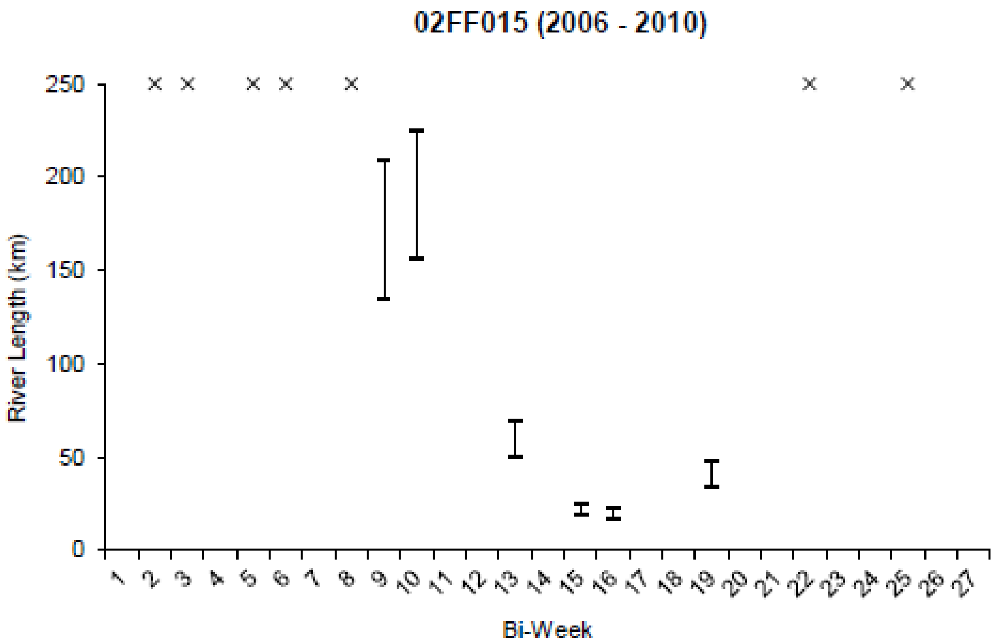


Figure A1-95. Gauging station 02FF012 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



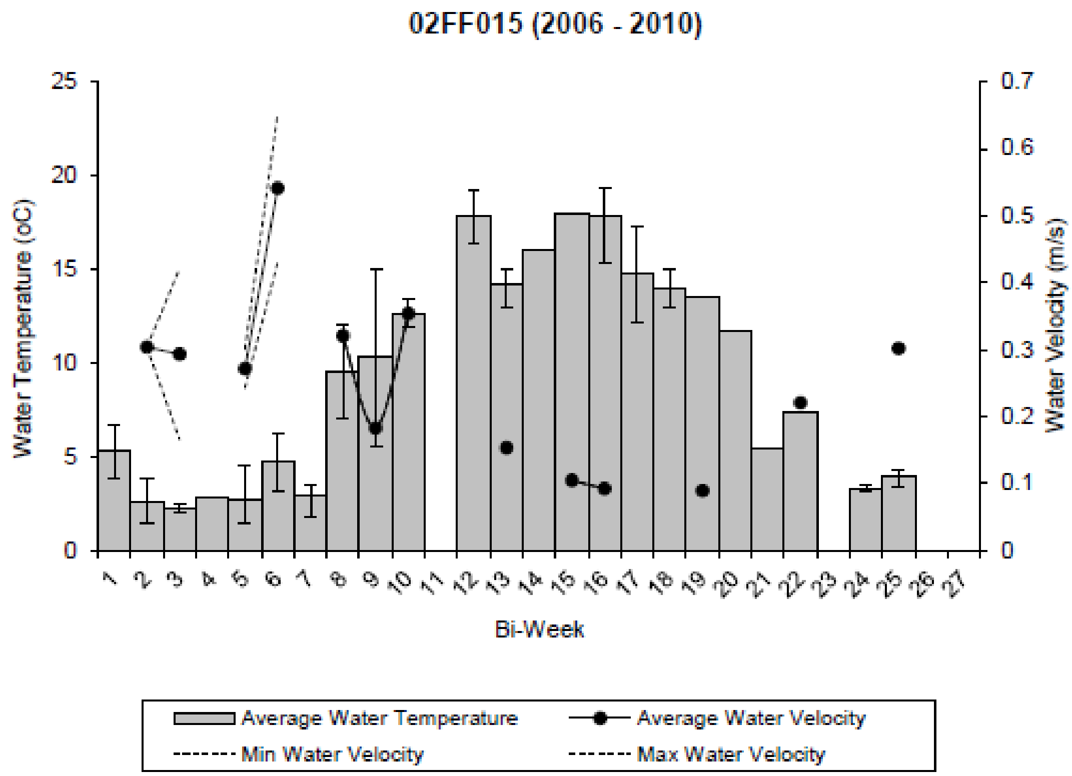
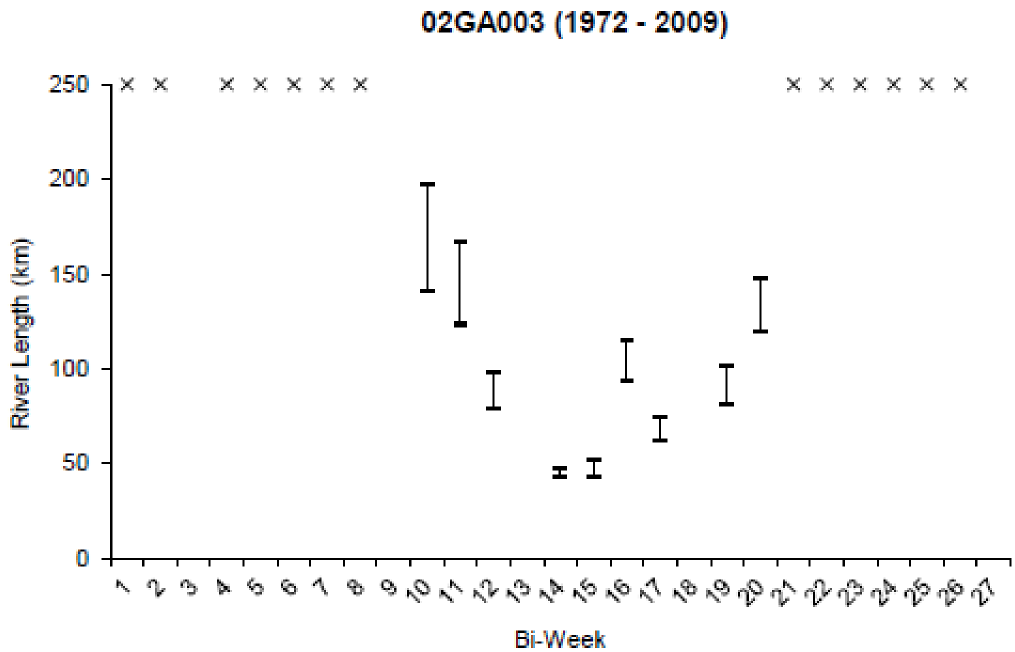


Figure A1-96. Gauging station 02FF015 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



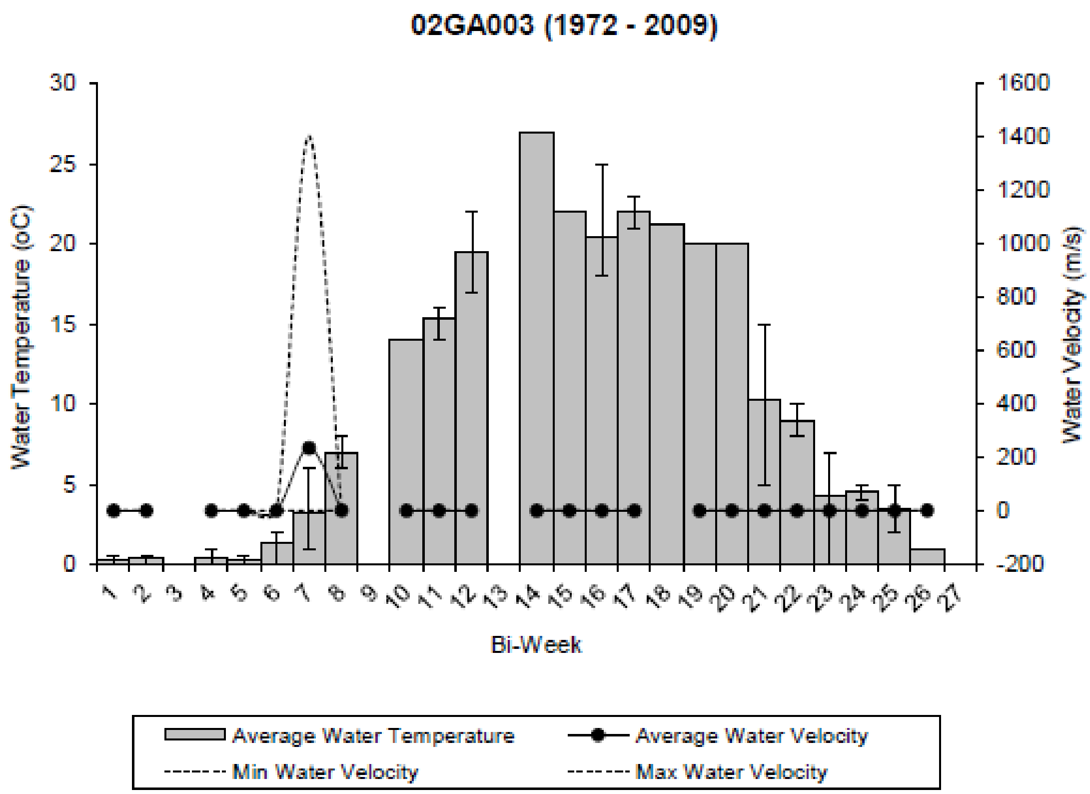
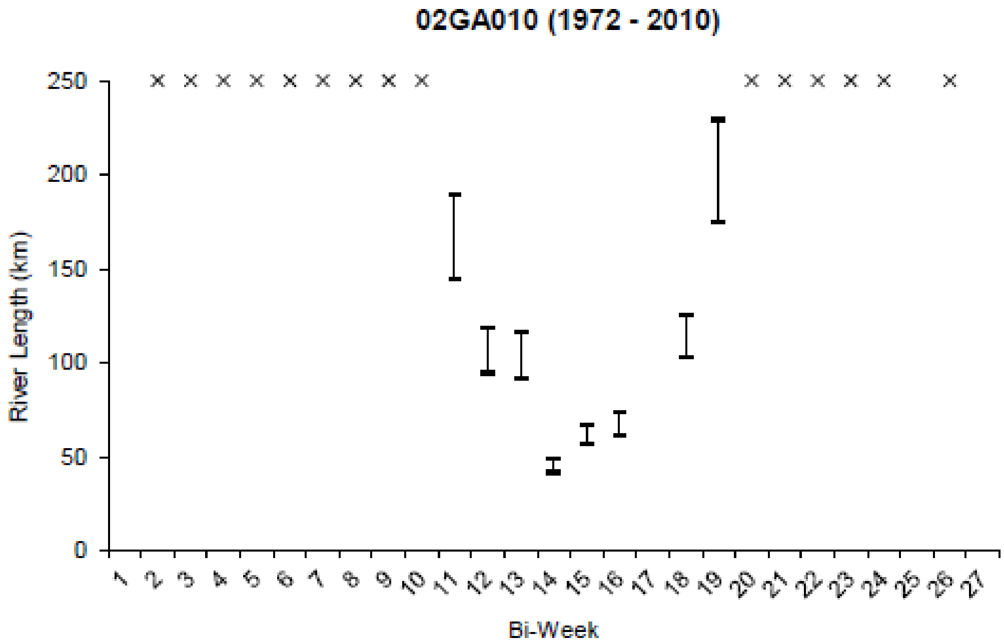


Figure A1-97. Gauging station 02GA003 data from 1972–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



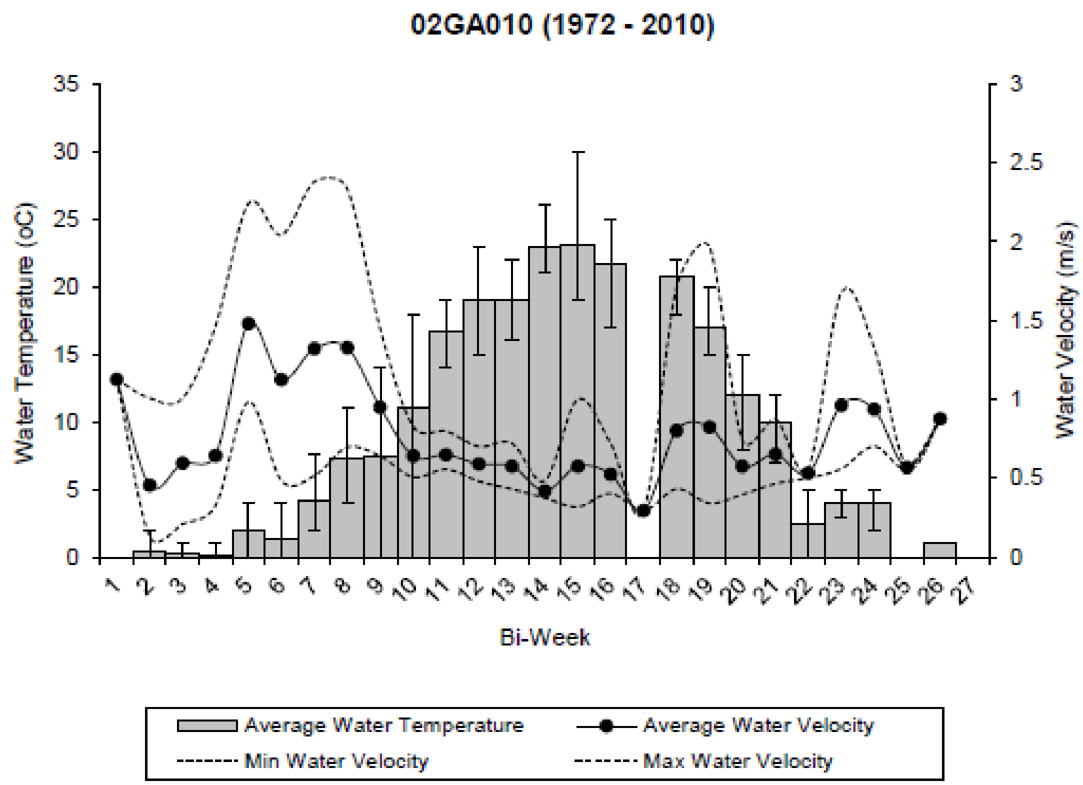
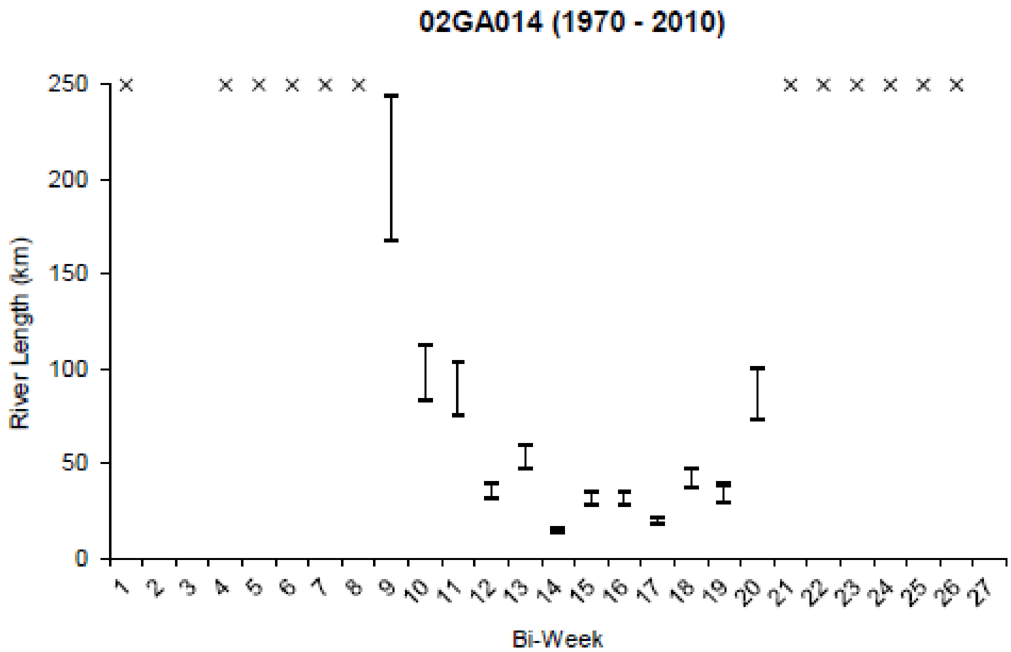


Figure A1-98. Gauging station 02GA010 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



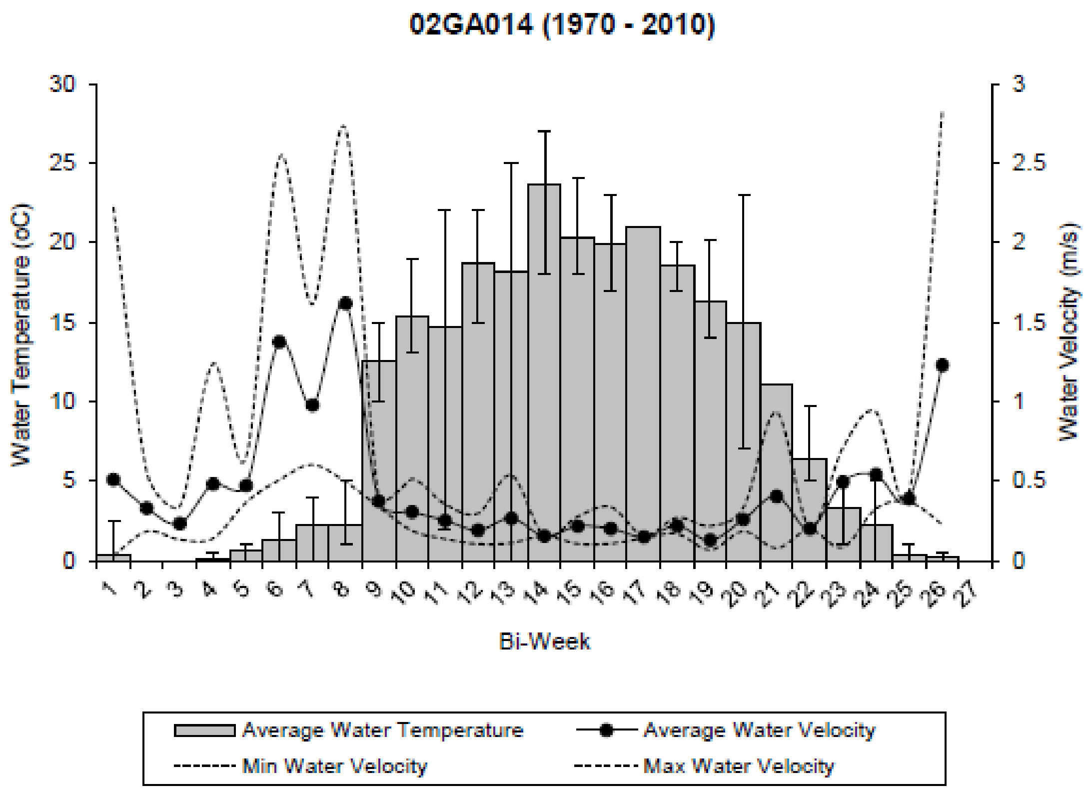


Figure A1-99. Gauging station 02GA014 data from 1970–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

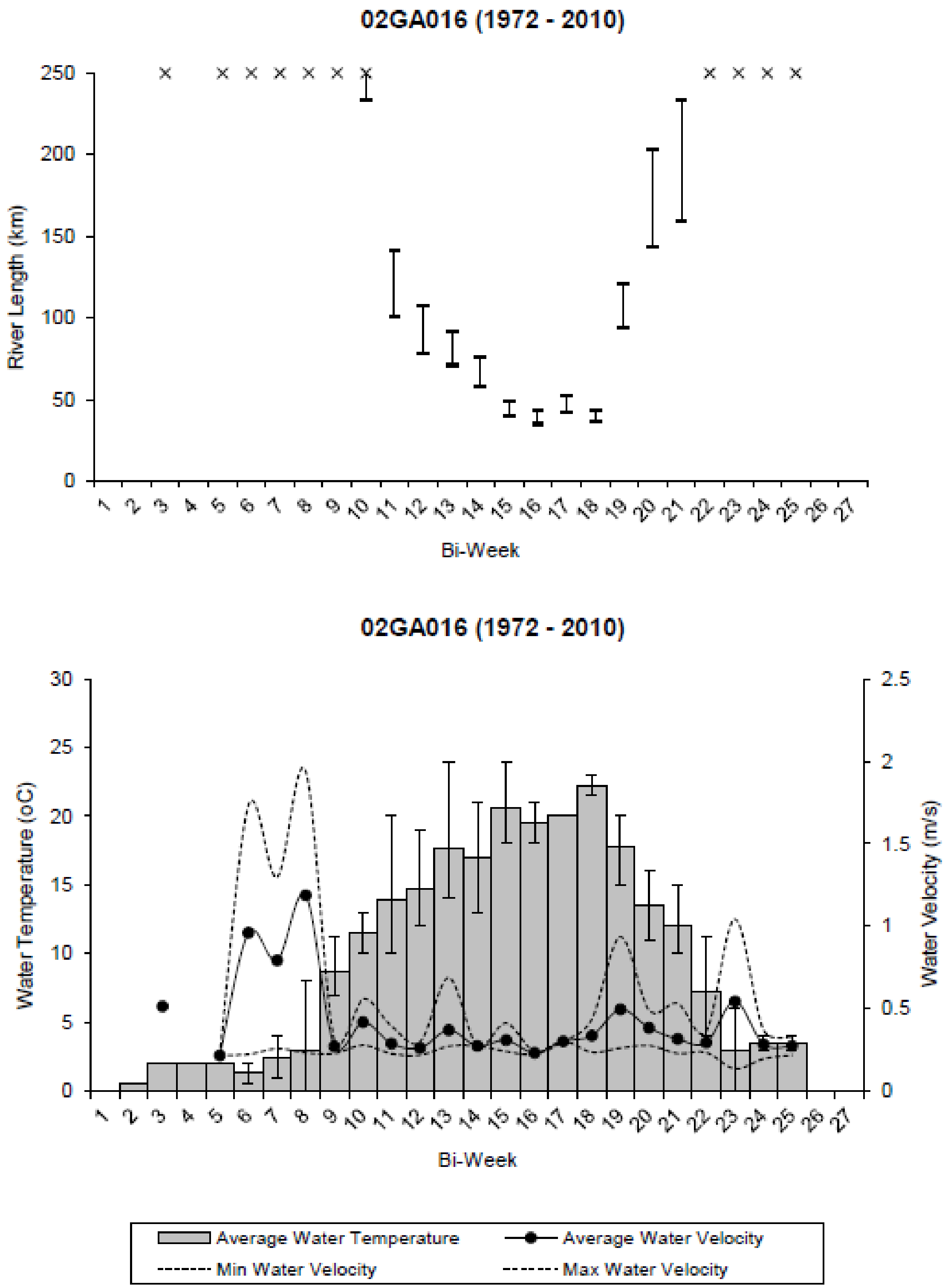
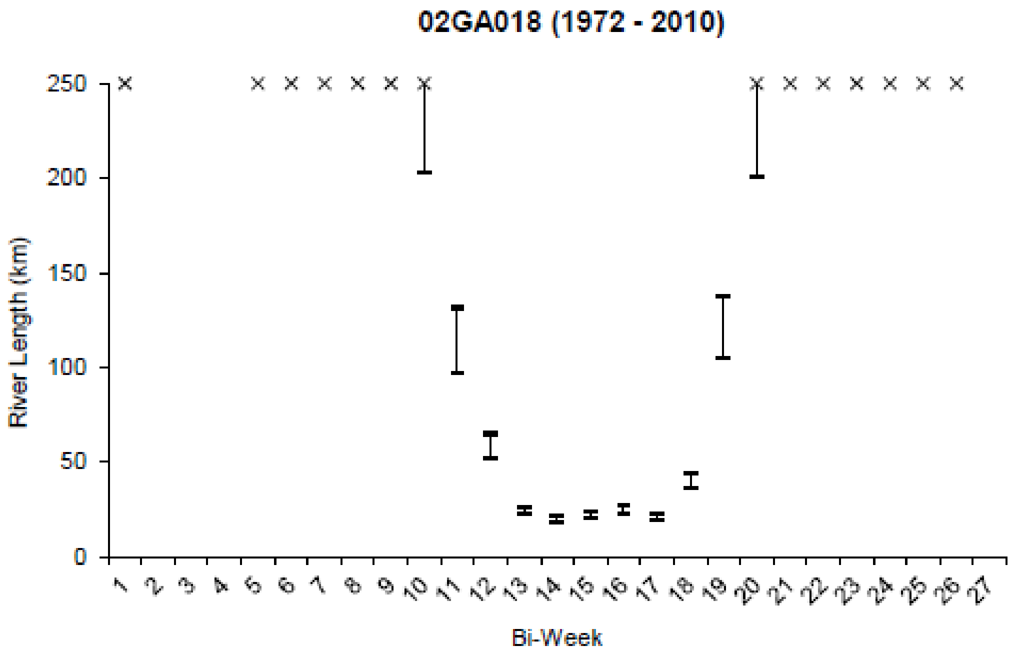


Figure A1-100. Gauging station 02GA016 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



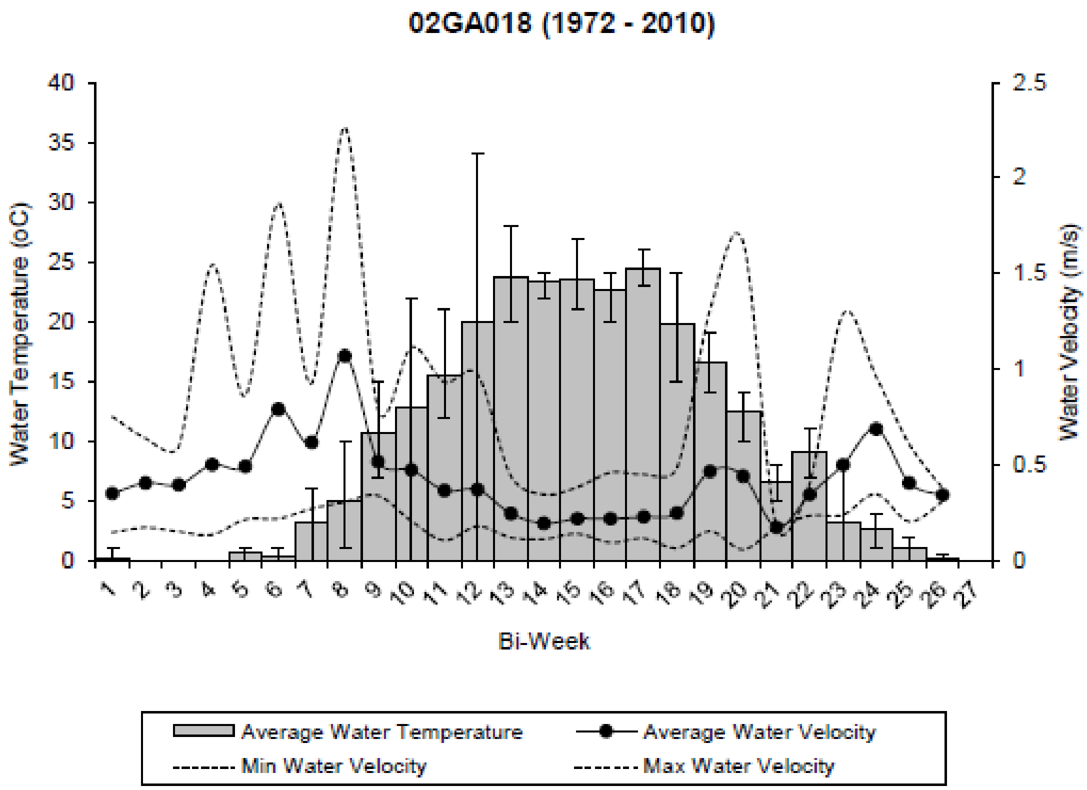


Figure A1-101. Gauging station 02GA018 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

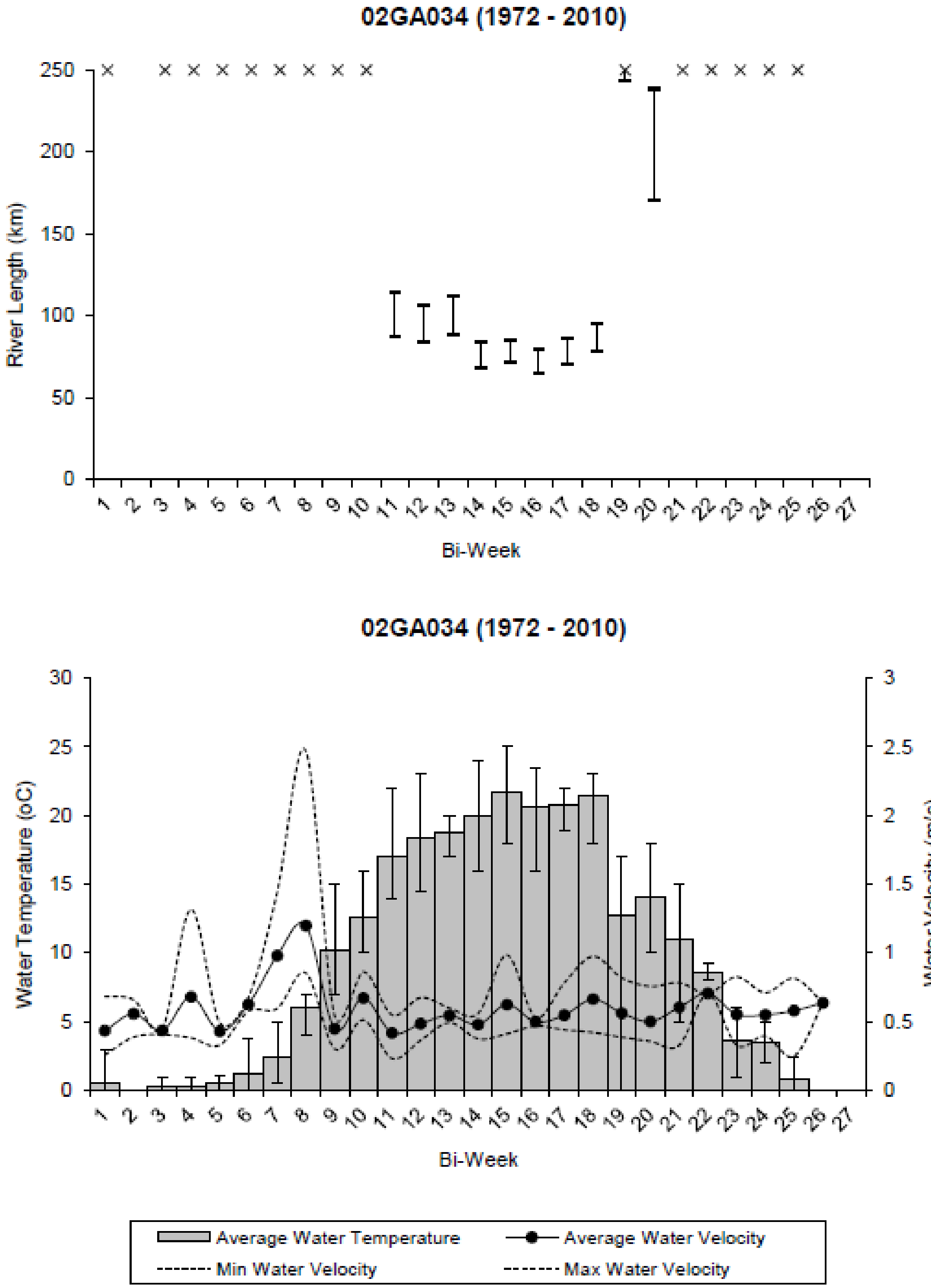


Figure A1-102. Gauging station 02GA034 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

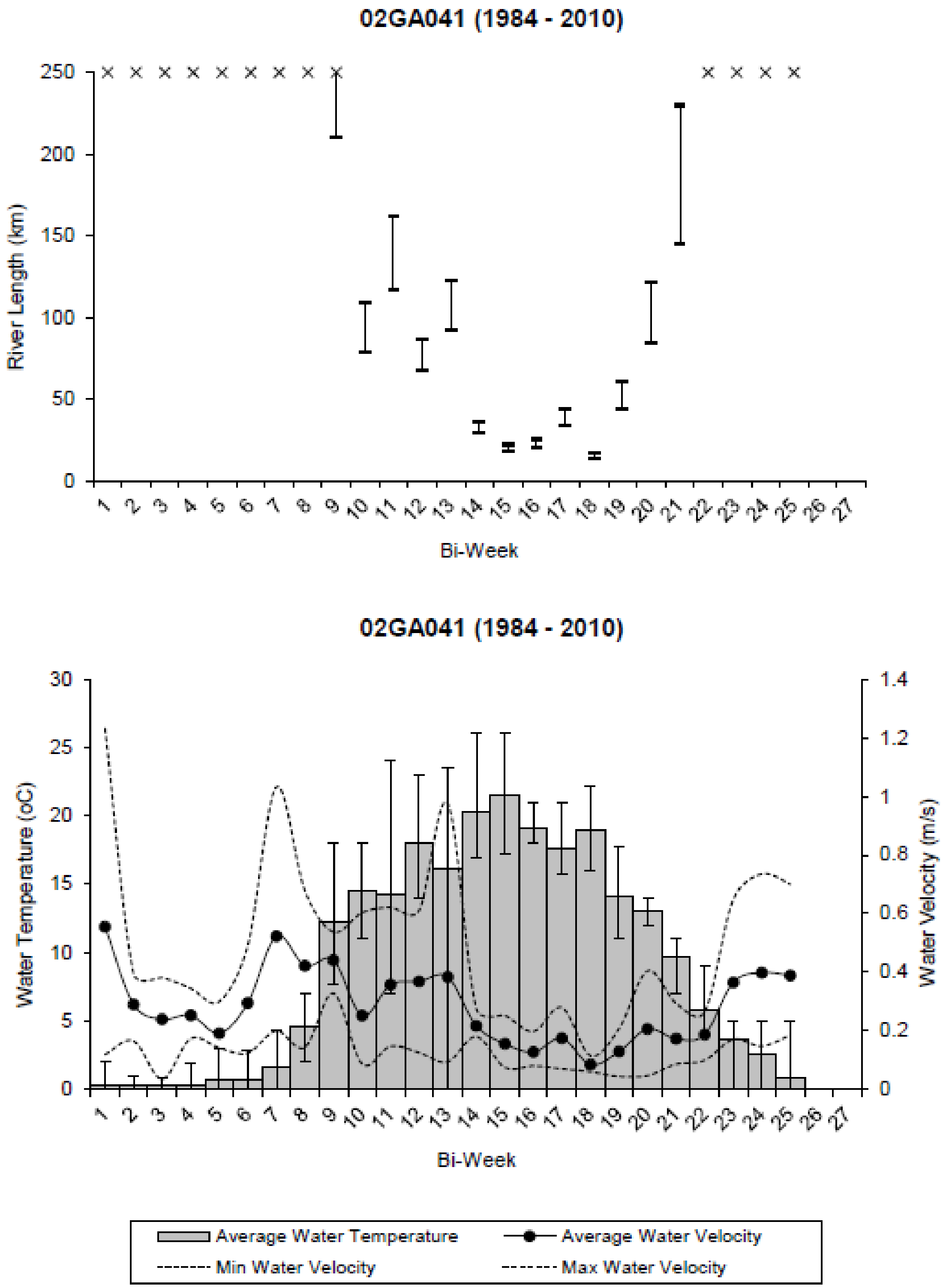
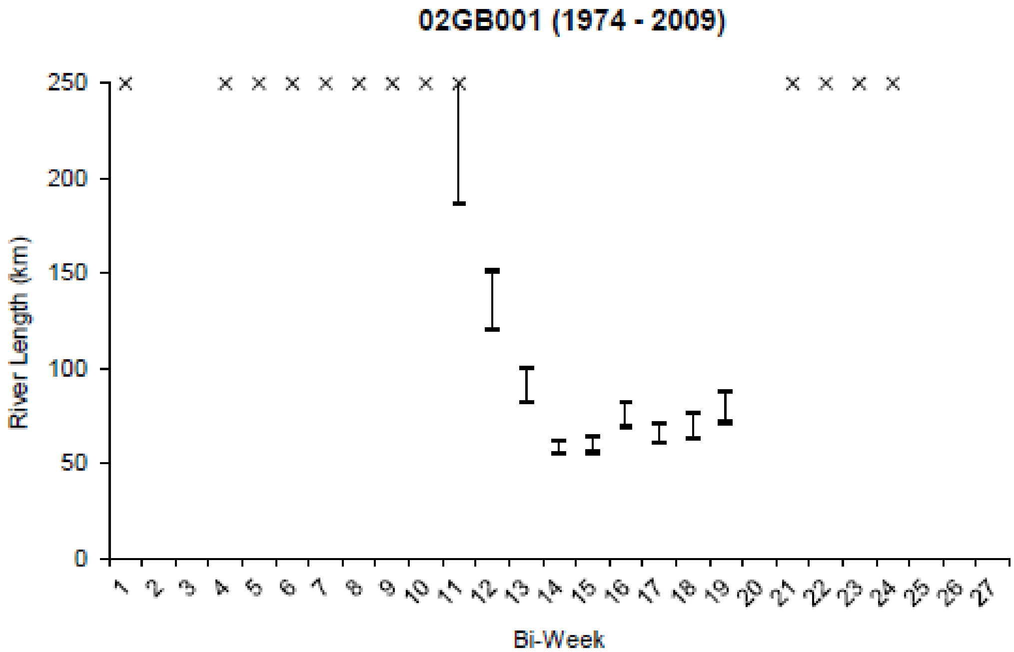


Figure A1-103. Gauging station 02GA041 data from 1984–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



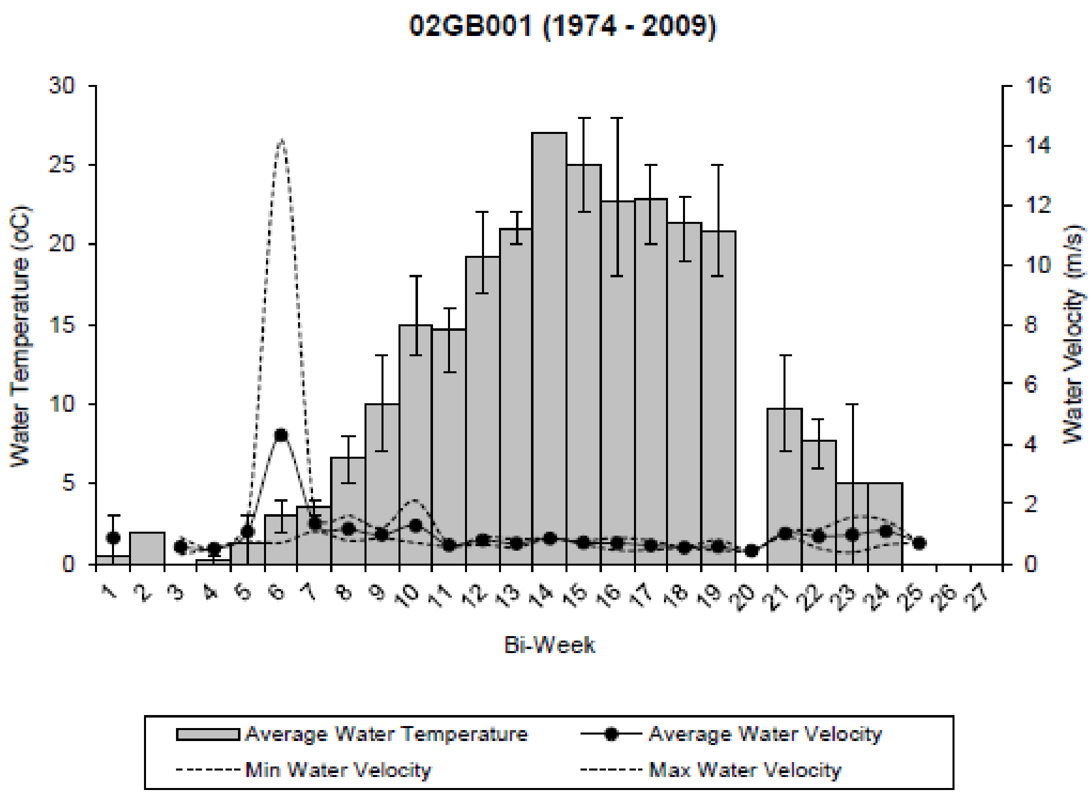
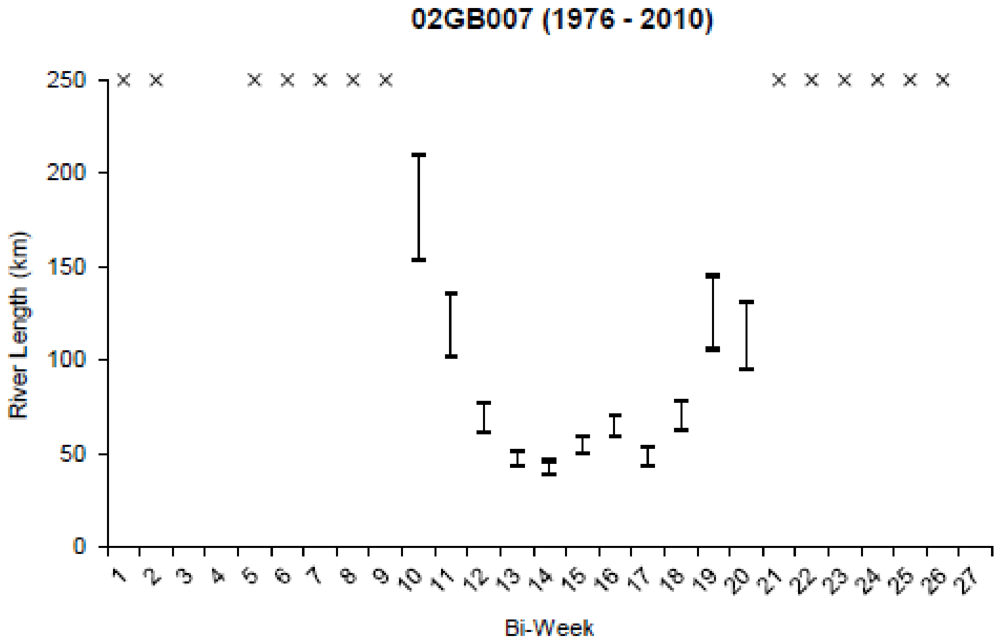


Figure A1-104. Gauging station 02GB001 data from 1974–2009. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



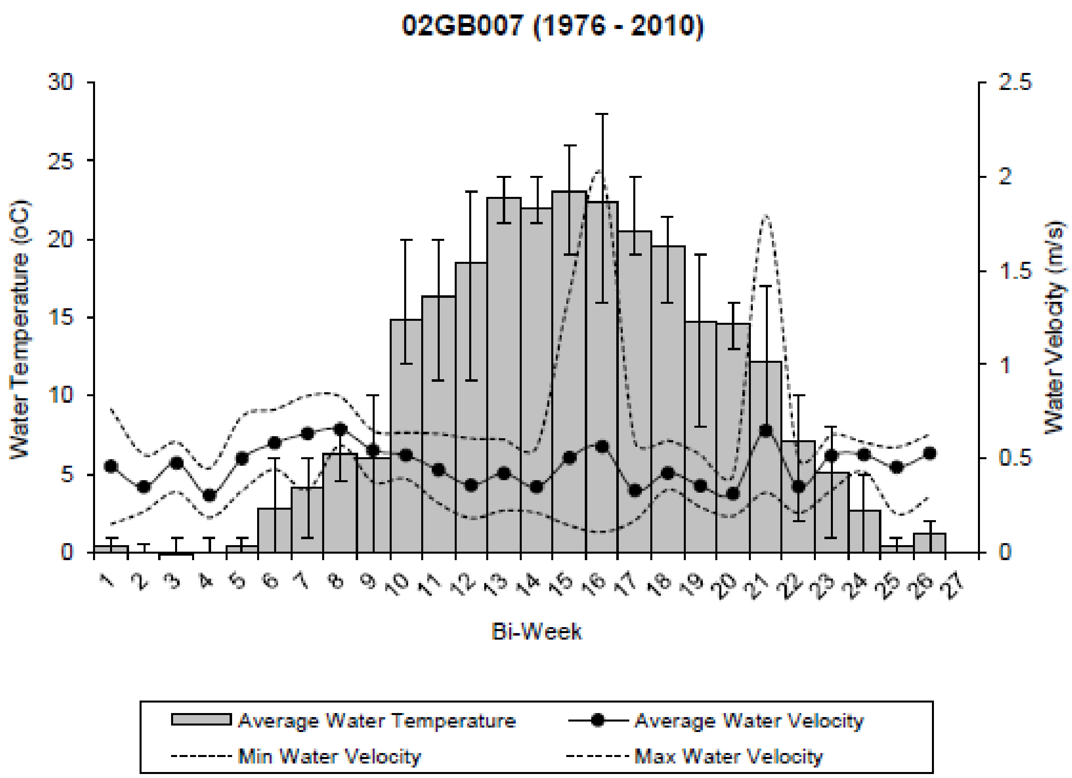
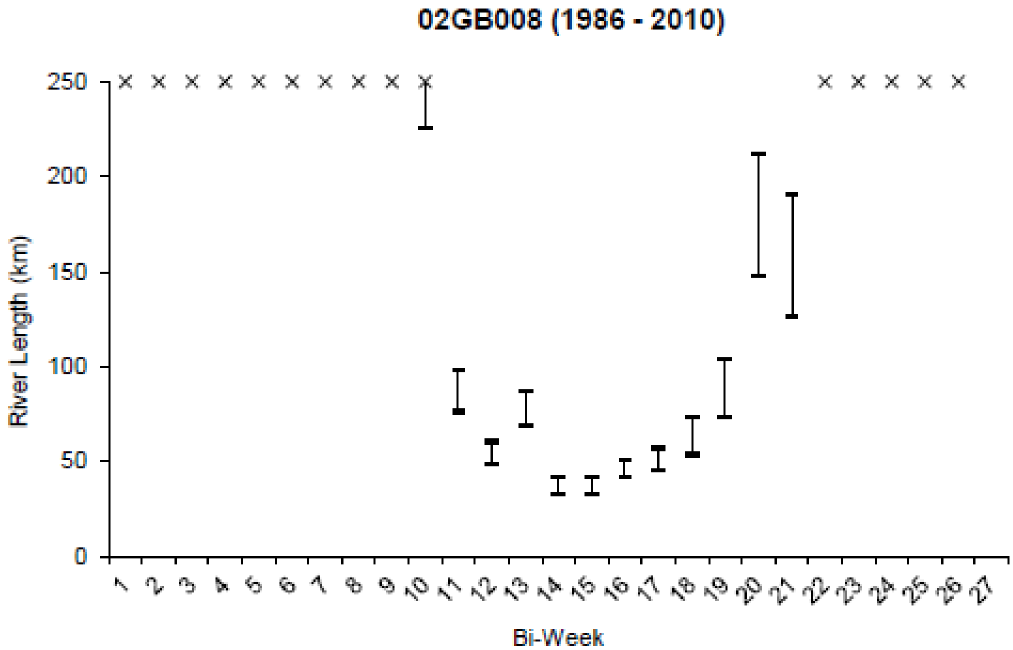


Figure A1-105. Gauging station 02GB007 data from 1976–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



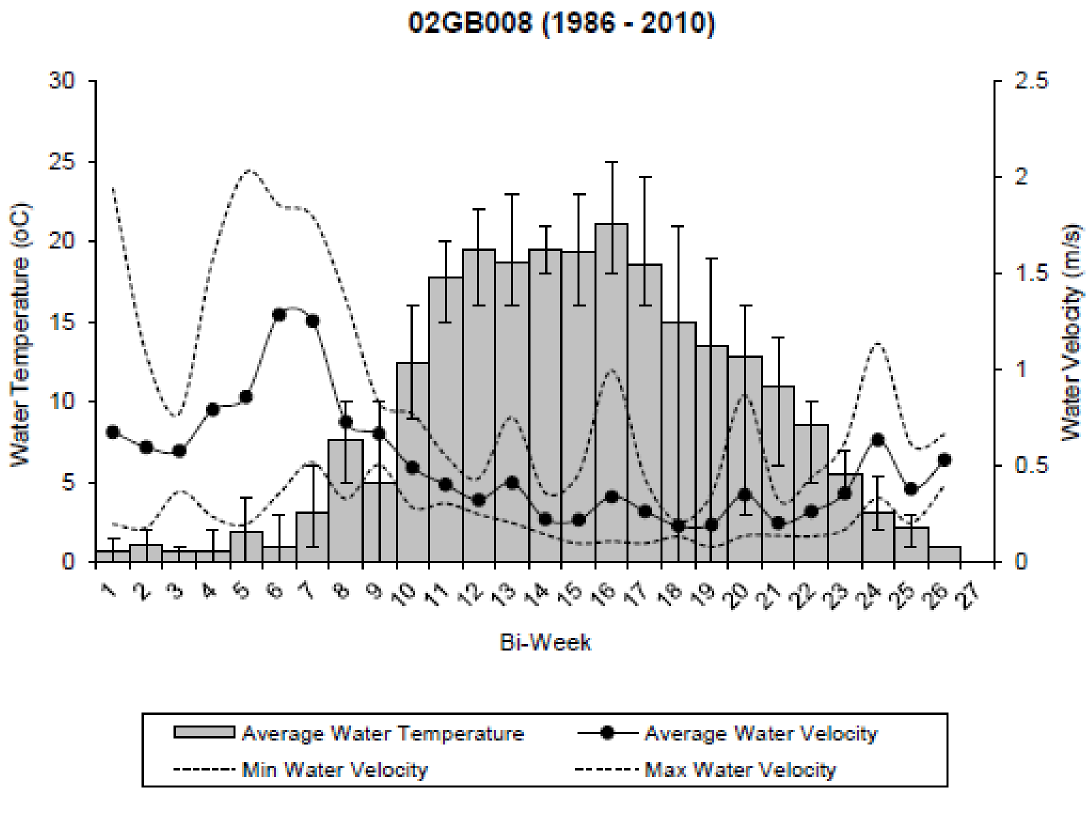
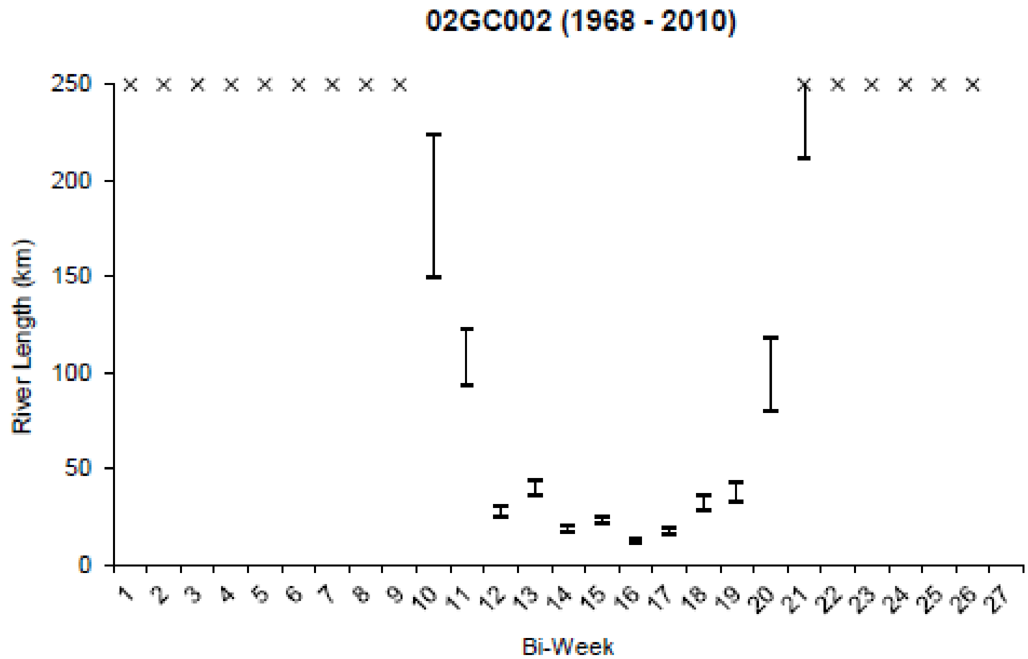


Figure A1-106. Gauging station 02GB008 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



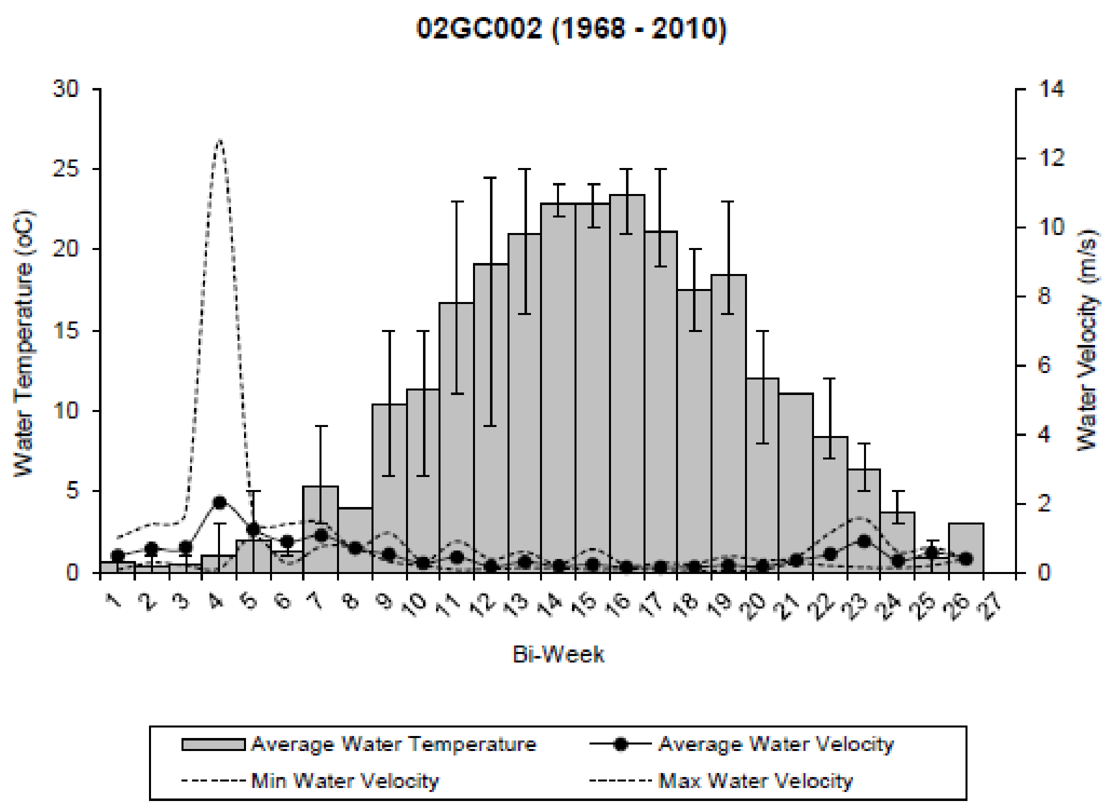


Figure A1-107. Gauging station 02GC002 data from 1968–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

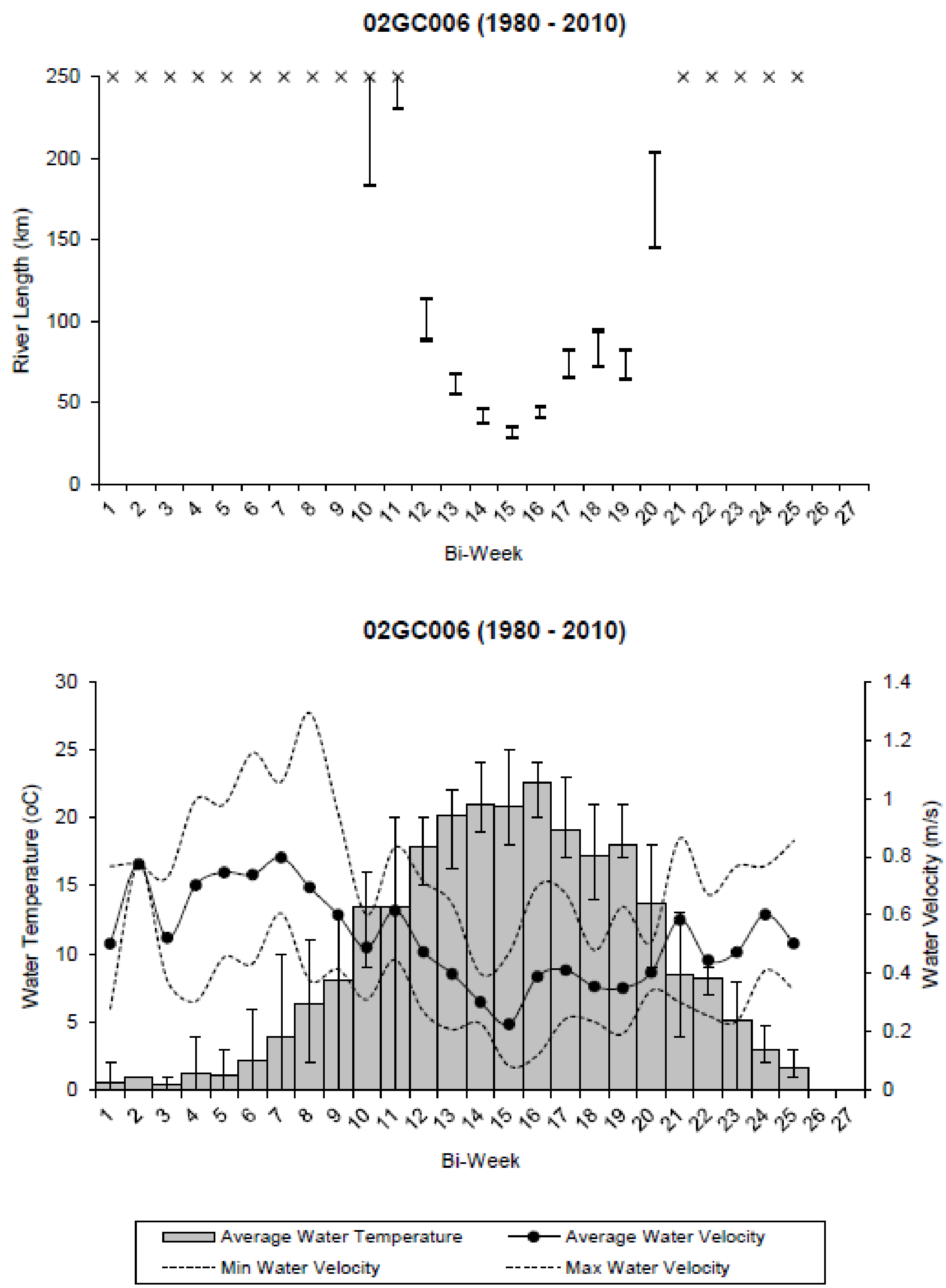
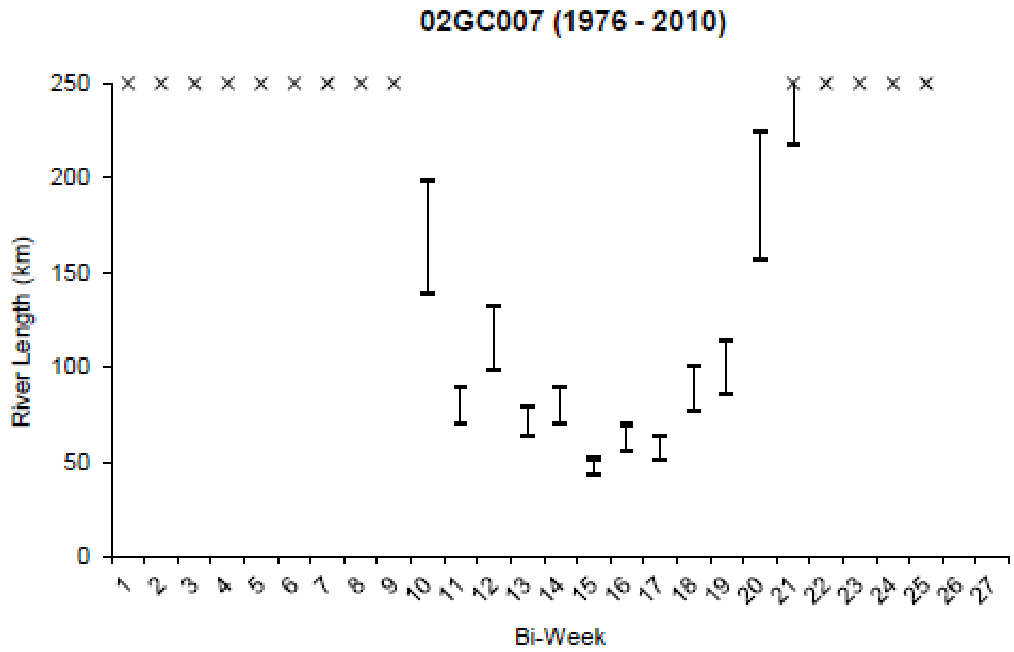


Figure A1-108. Gauging station 02GC006 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



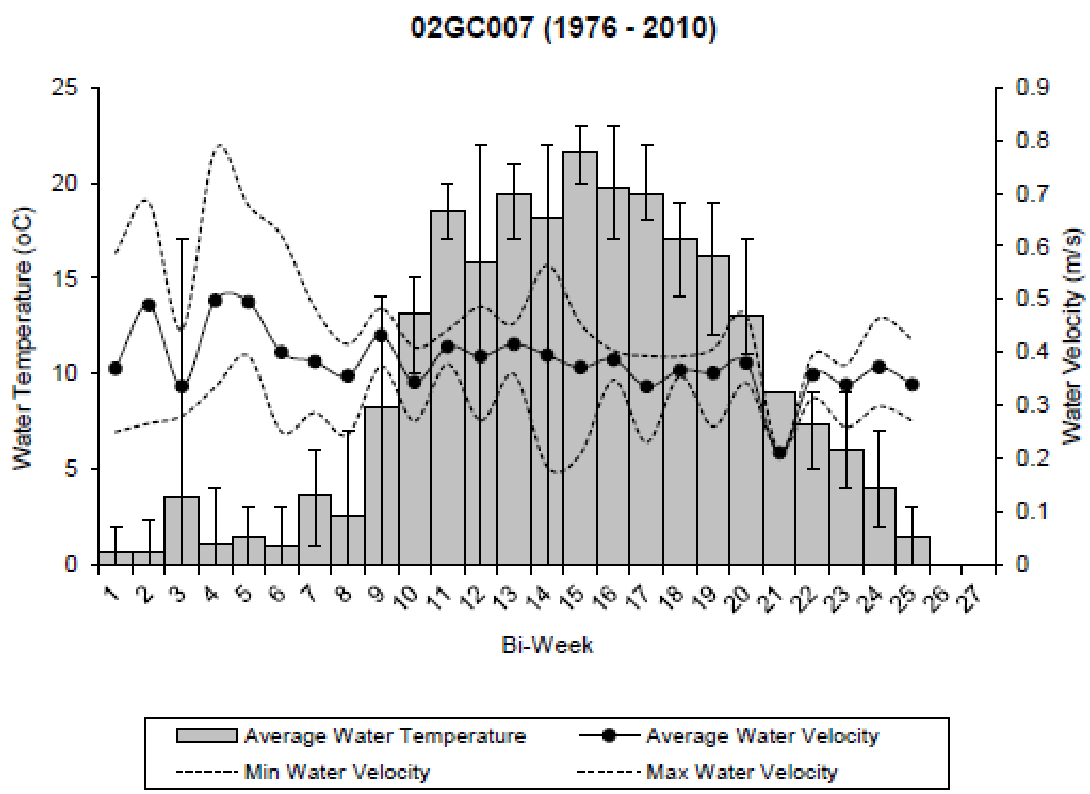
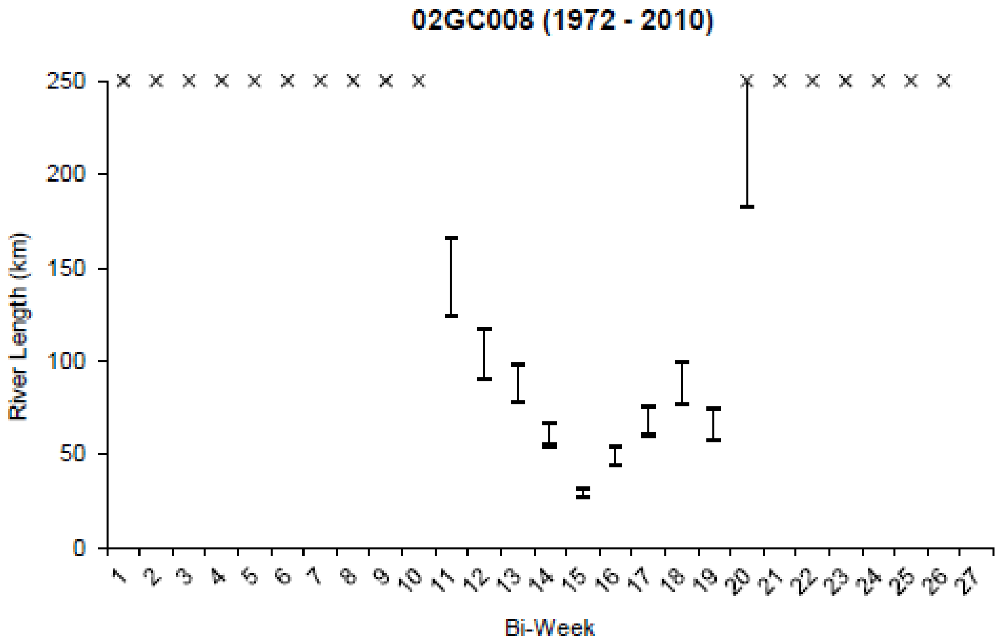


Figure A1-109. Gauging station 02GC007 data from 1976–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



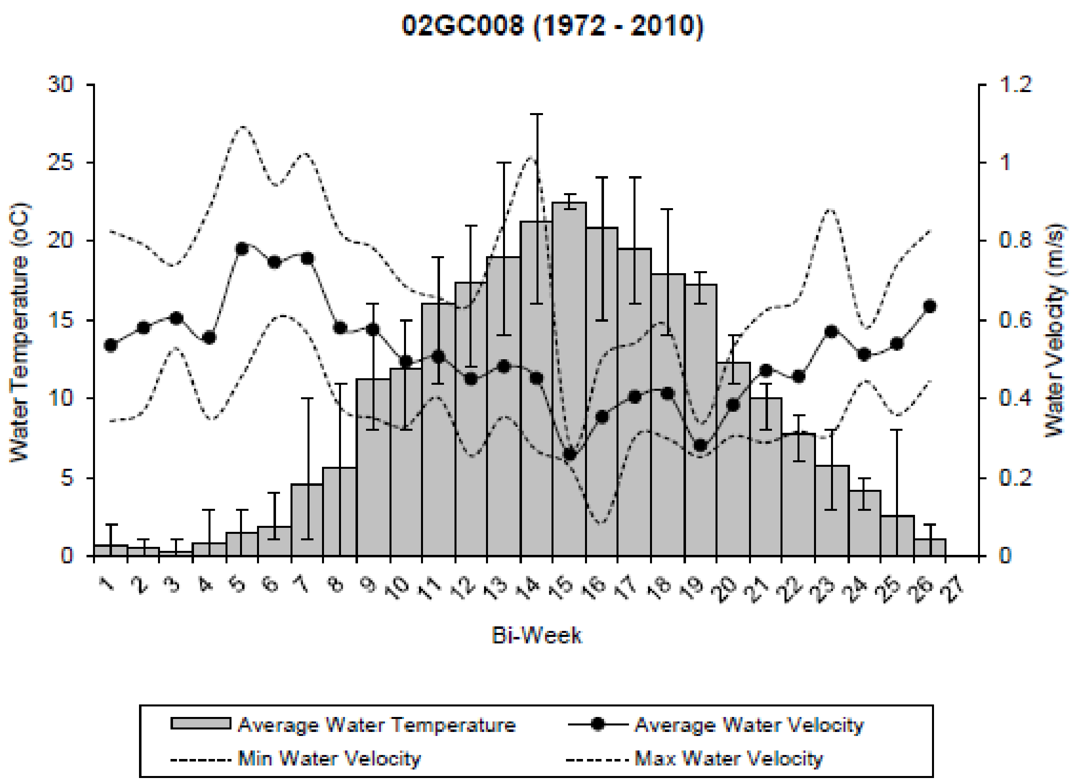


Figure A1-110. Gauging station 02GC008 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

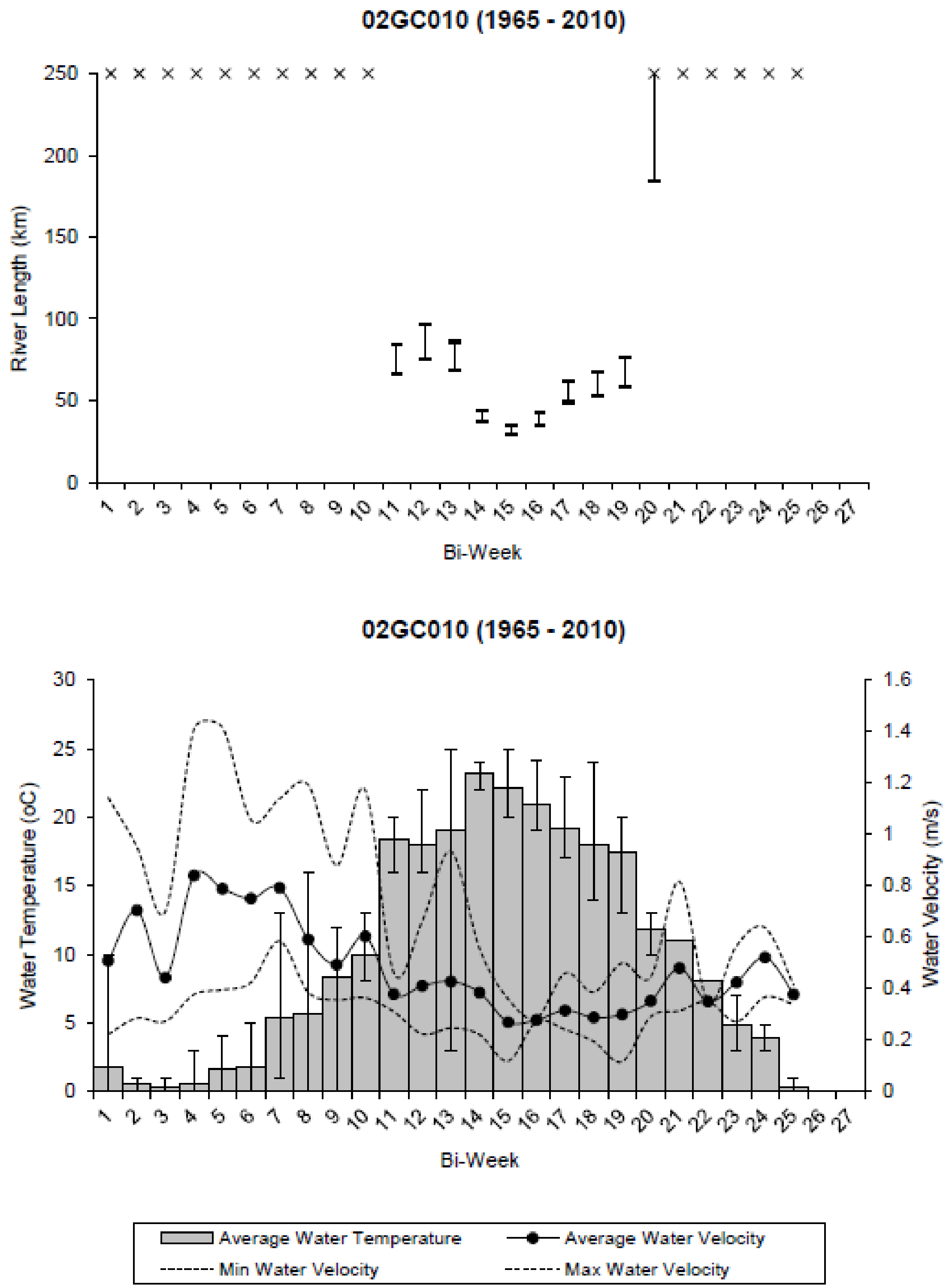
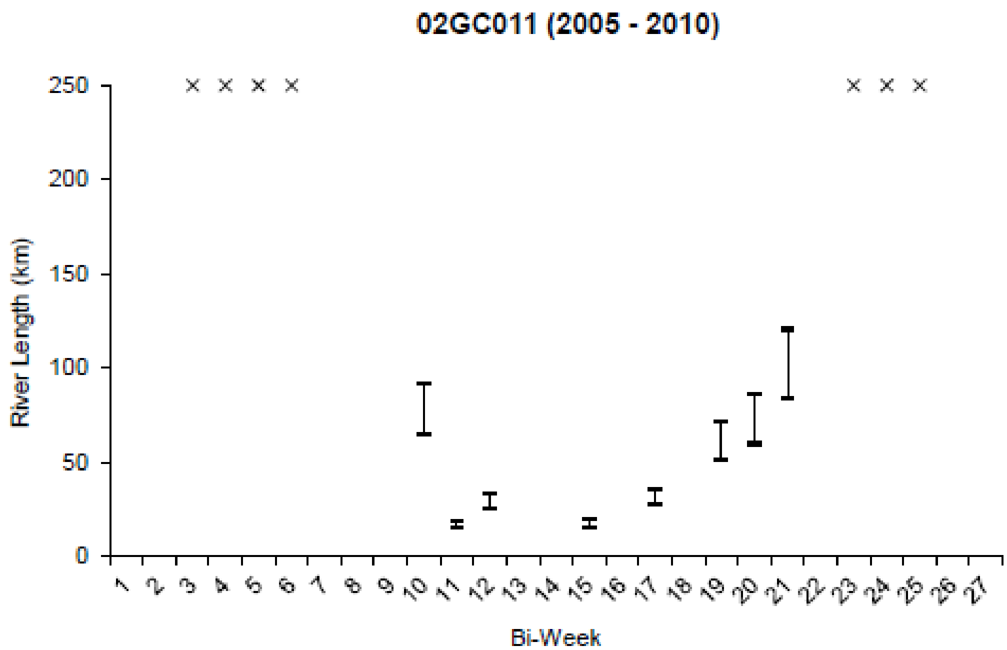


Figure A1-111. Gauging station 02GC010 data from 1965–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



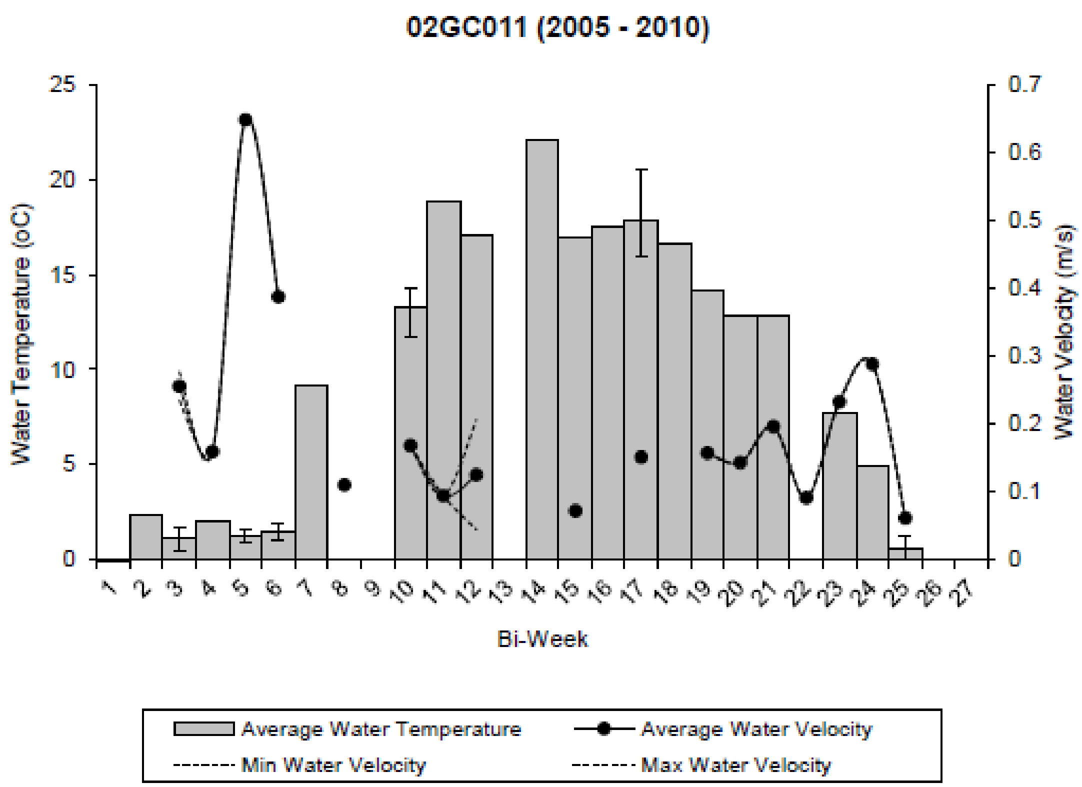
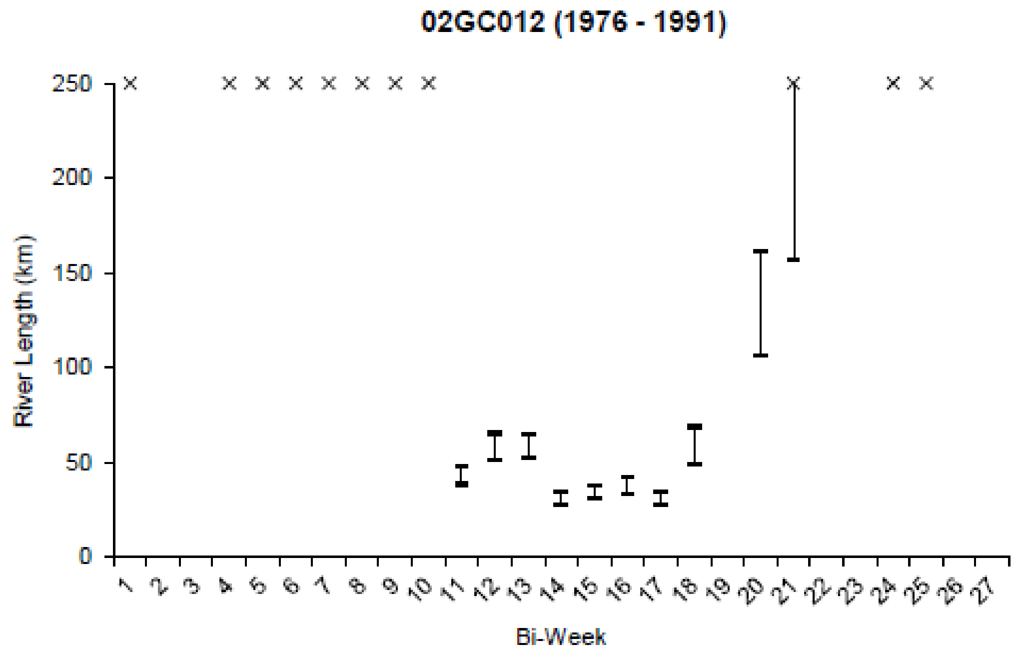


Figure A1-112. Gauging station 02GC011 data from 2005–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



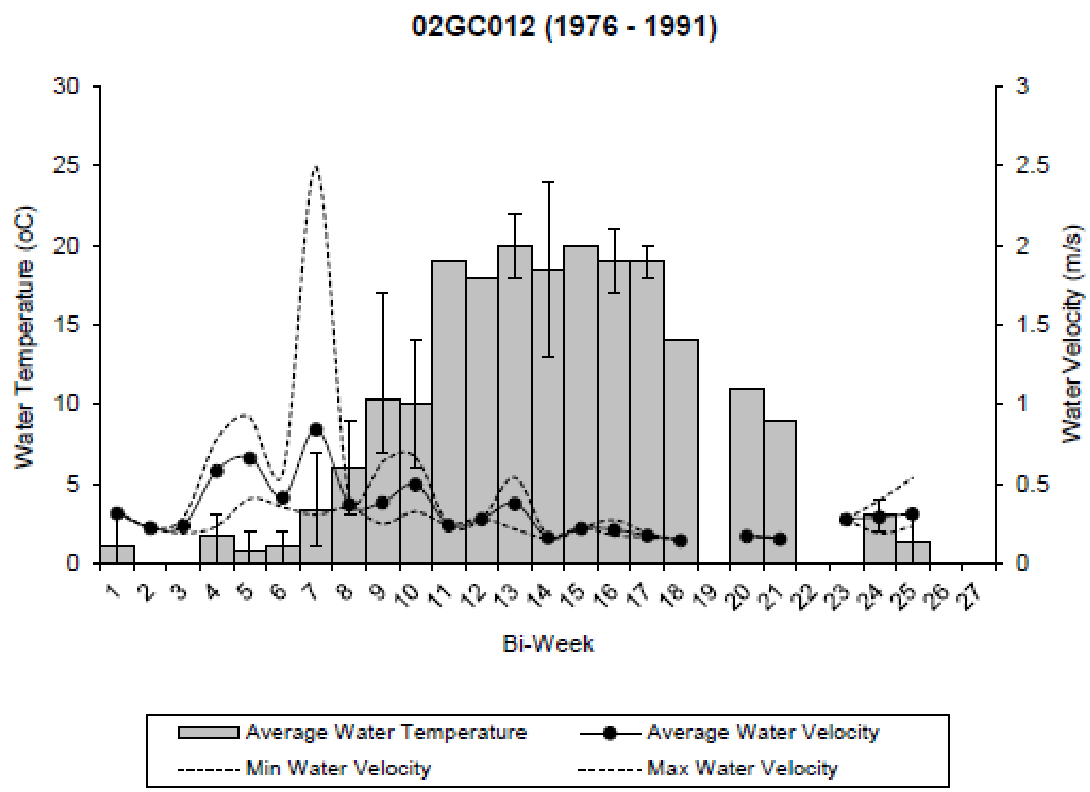
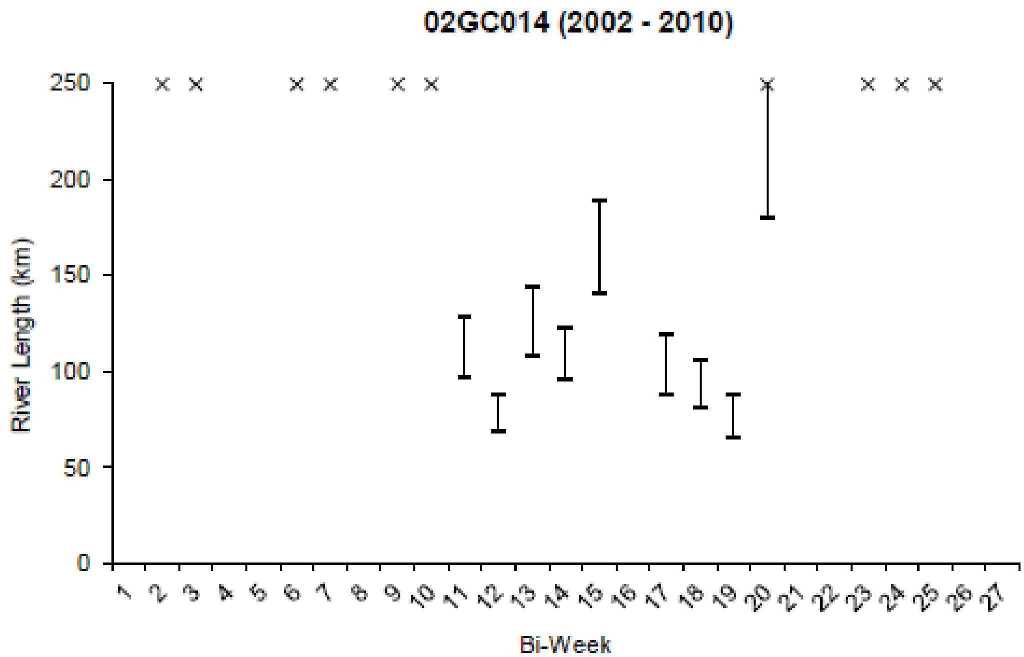


Figure A1-113. Gauging station 02GC012 data from 1976–1991. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



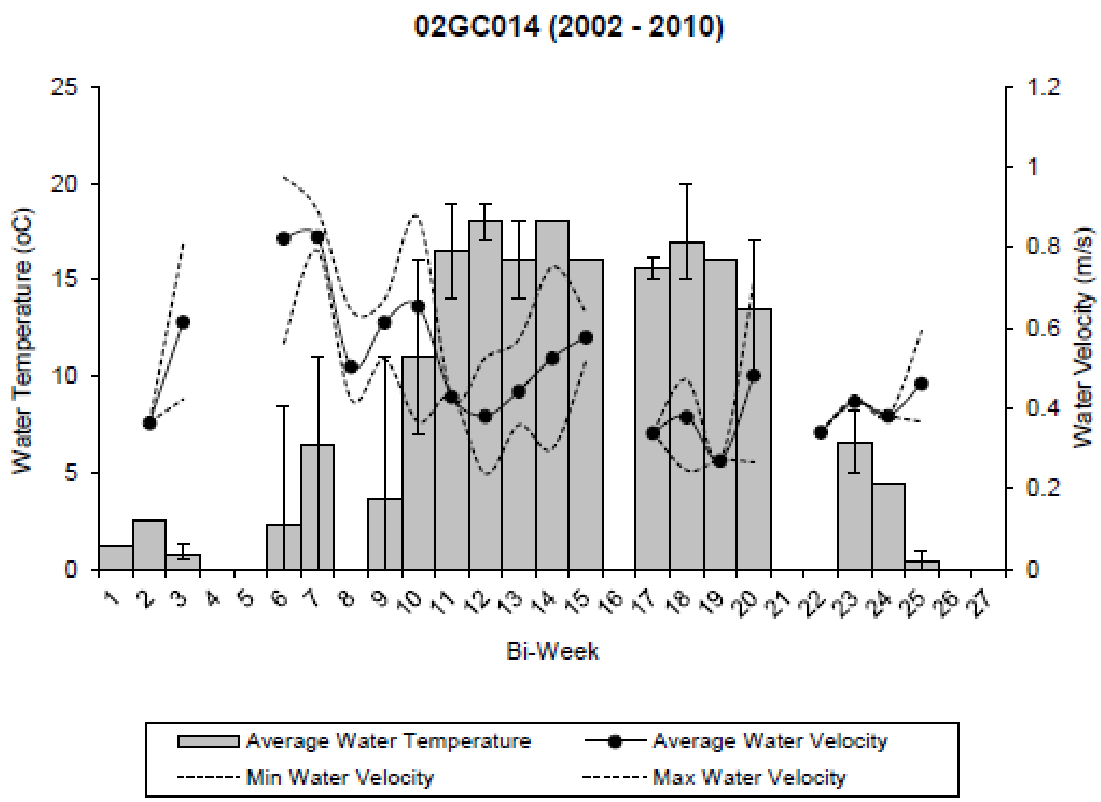
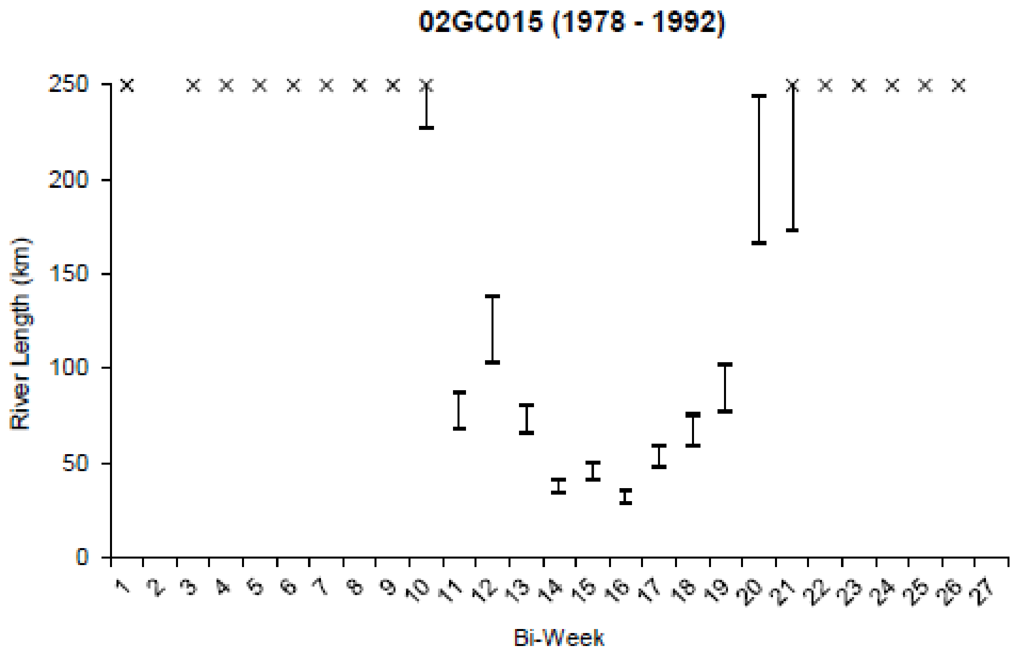


Figure A1-114. Gauging station 02GC014 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



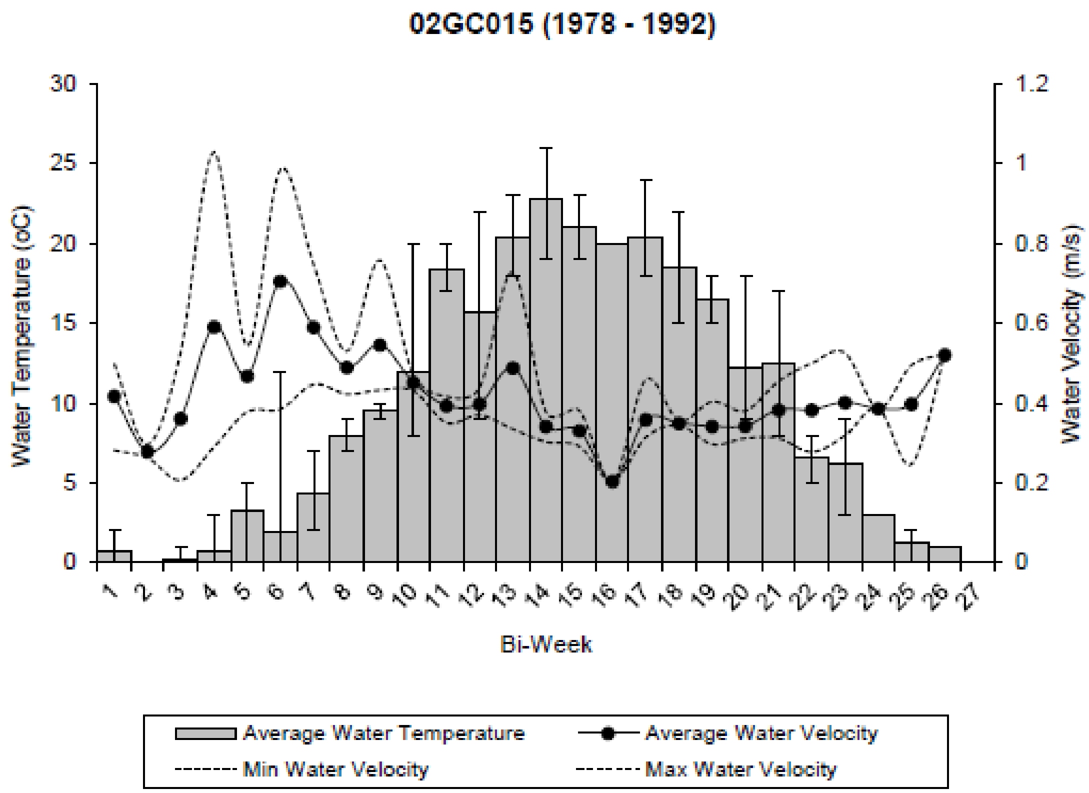
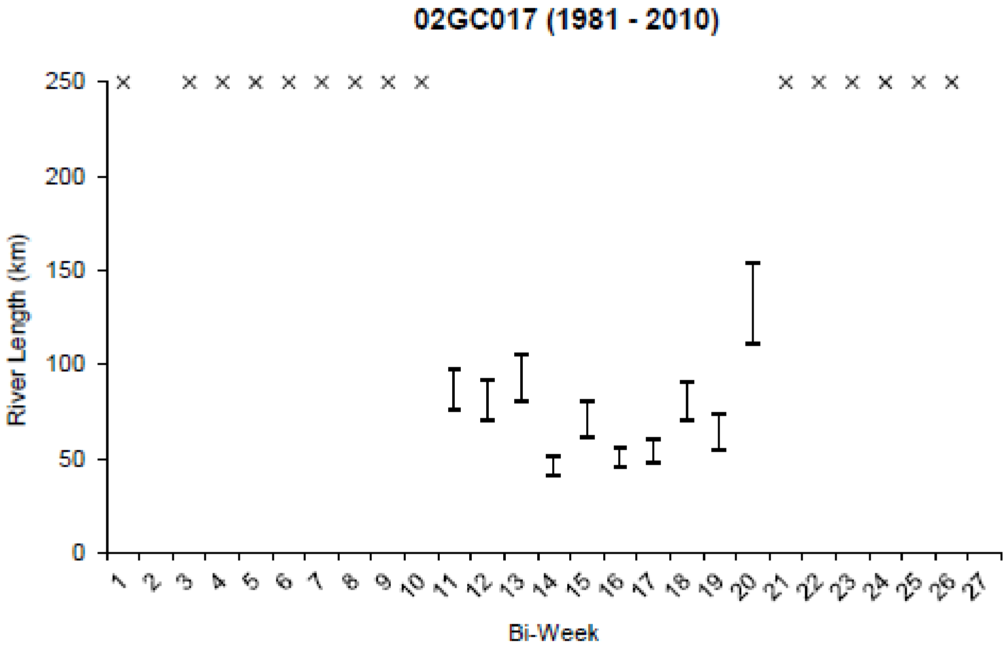


Figure A1-115. Gauging station 02GC015 data from 1978–1992. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



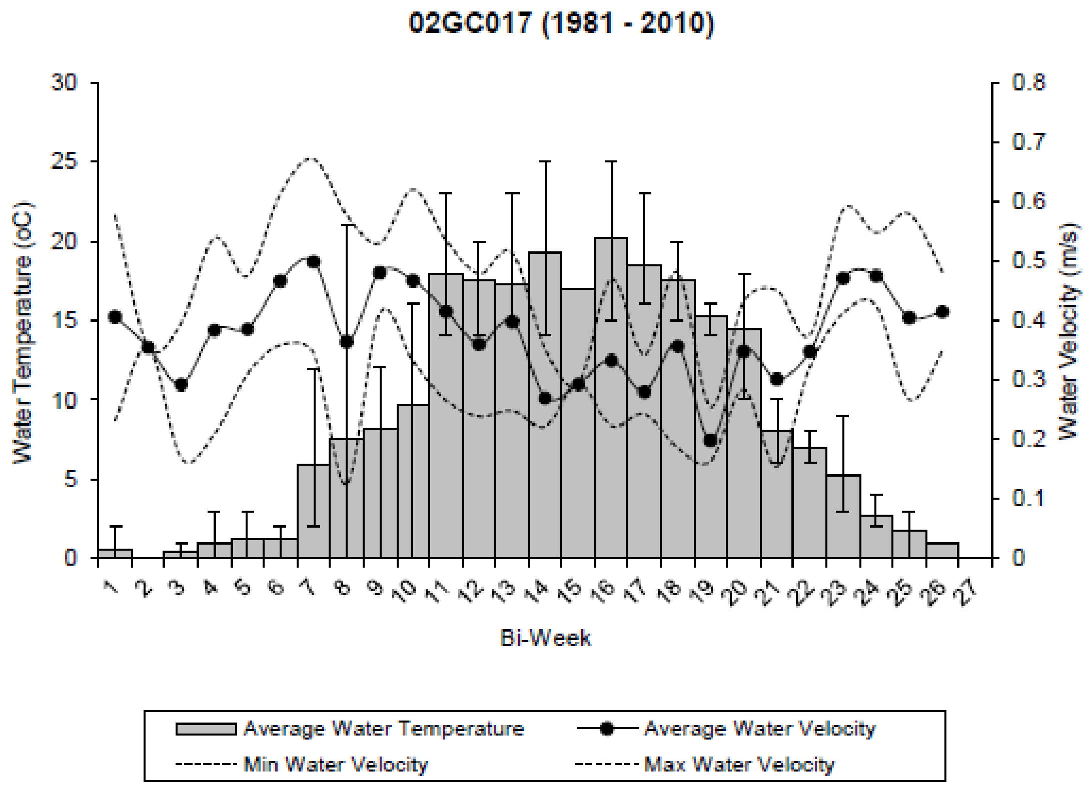
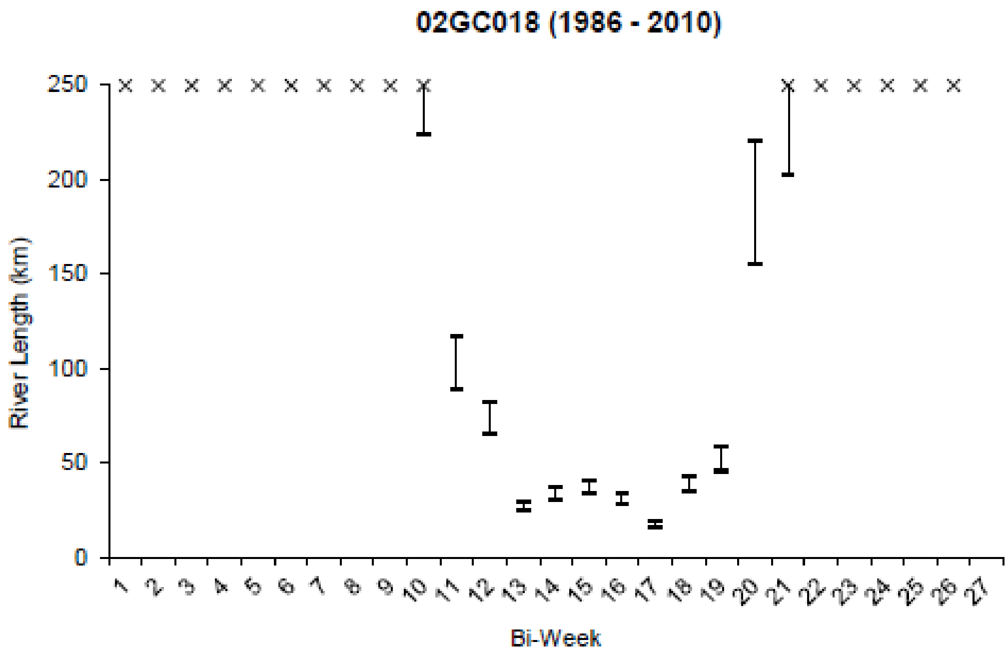


Figure A1-116. Gauging station 02GC017 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



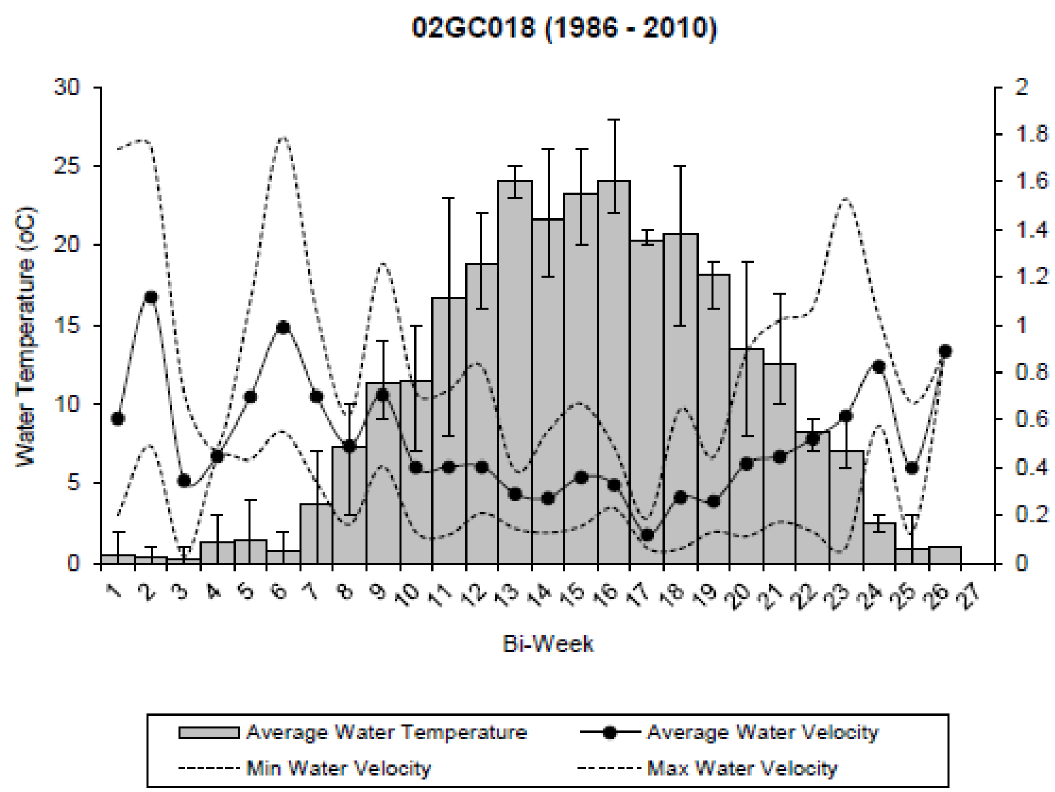
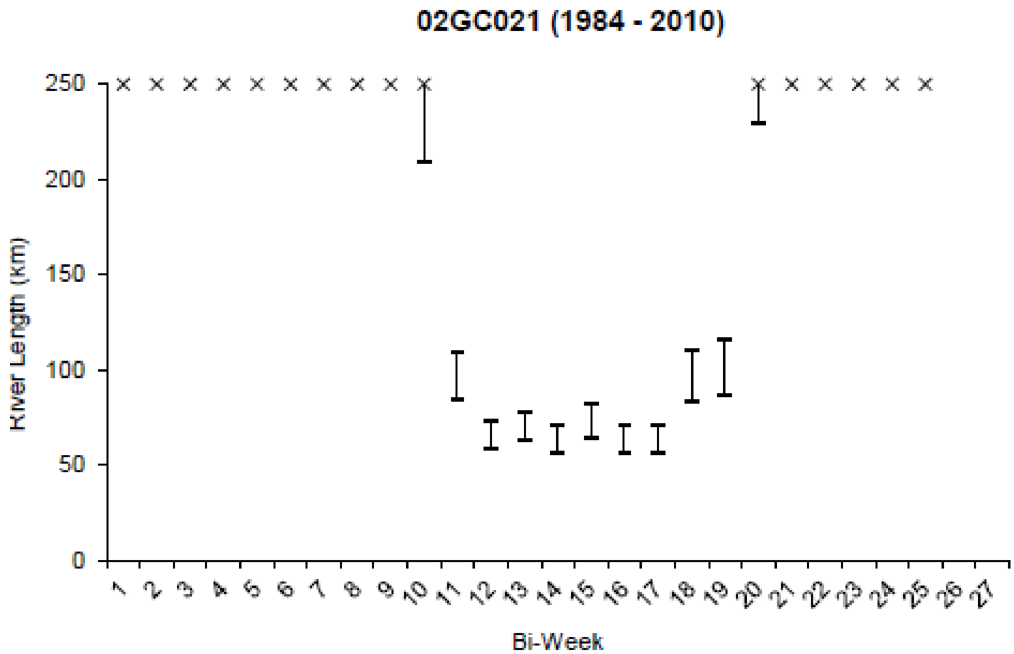


Figure A1-117. Gauging station 02GC018 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



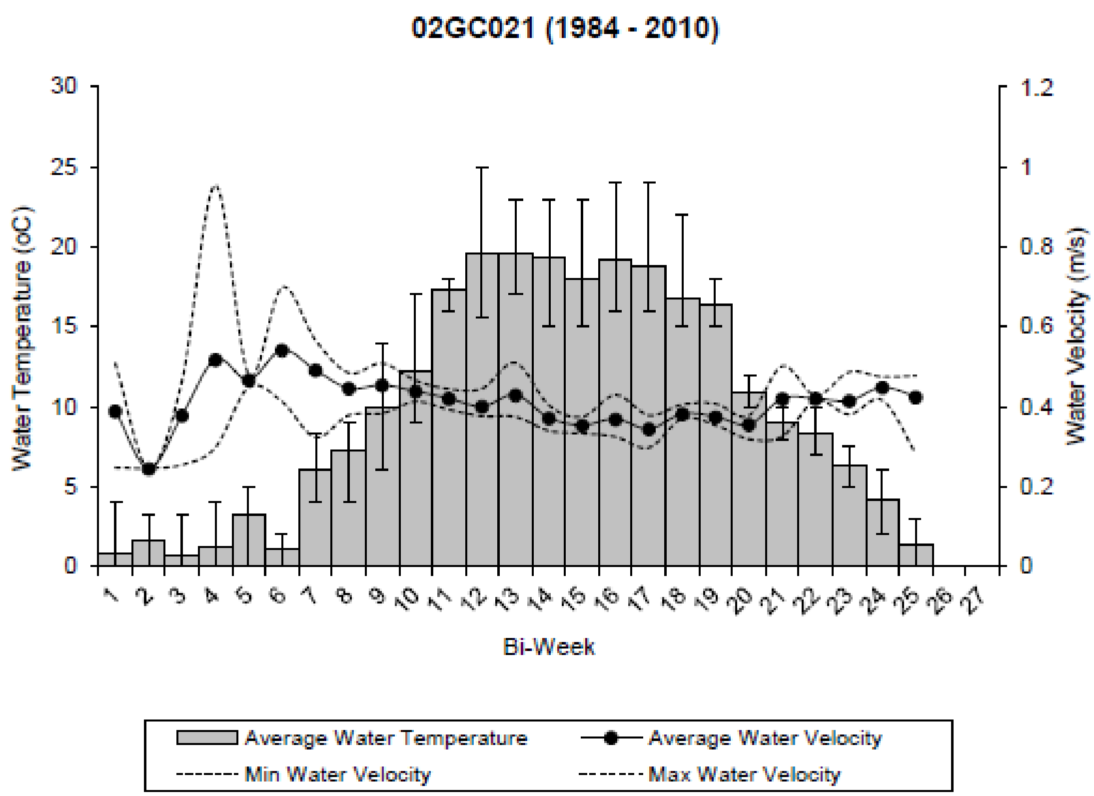
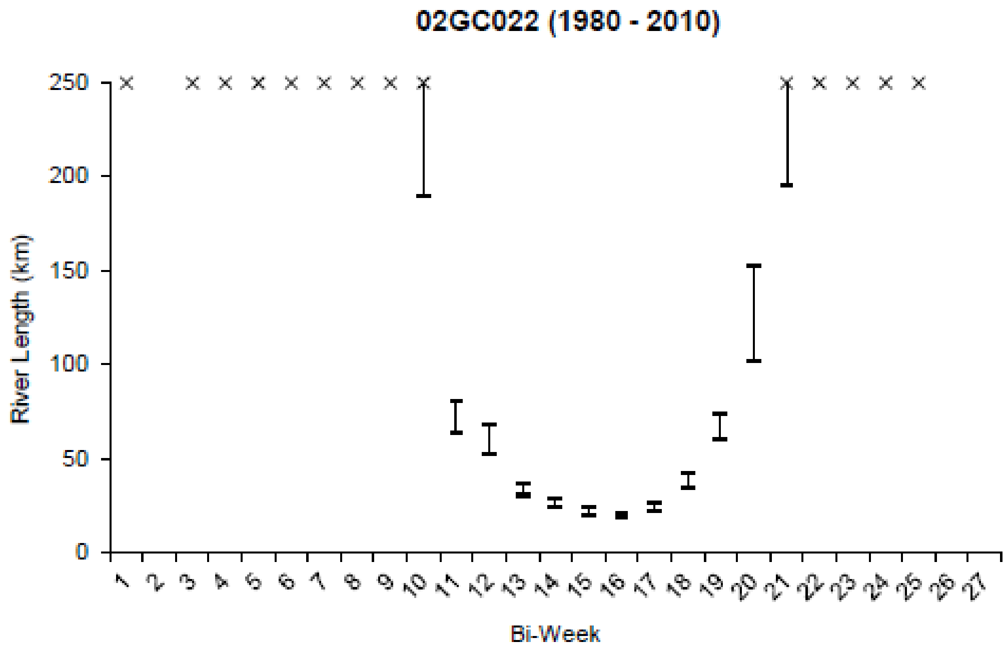


Figure A1-118. Gauging station 02GC021 data from 1984–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



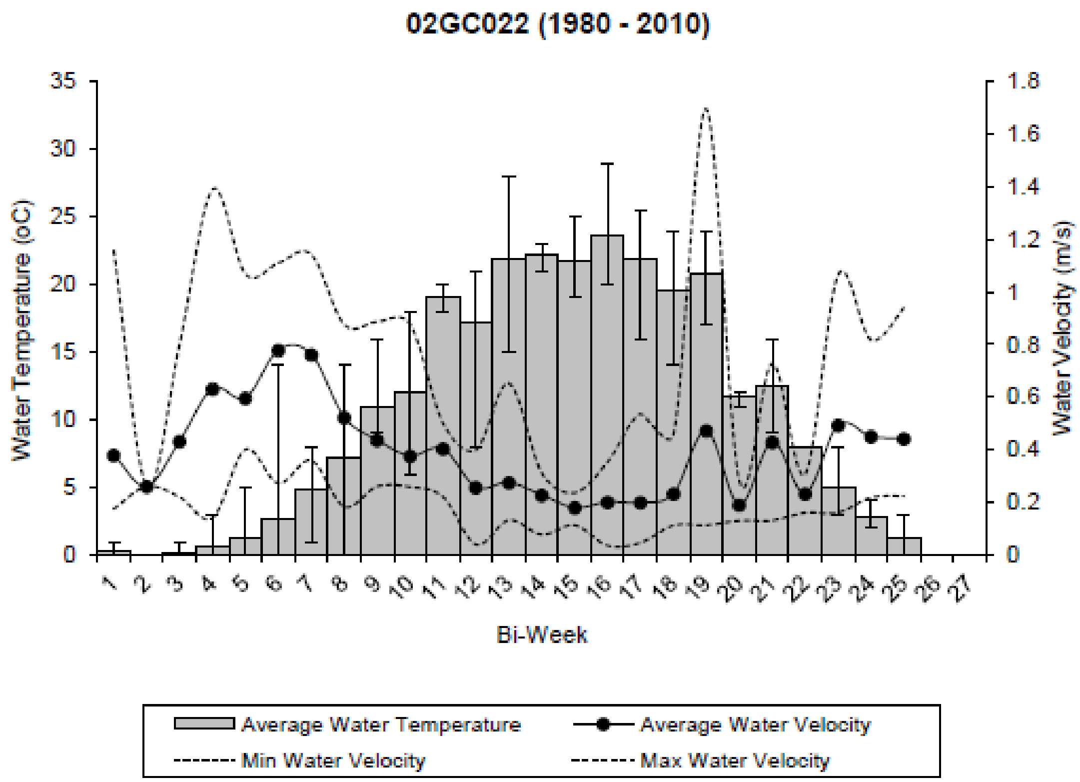
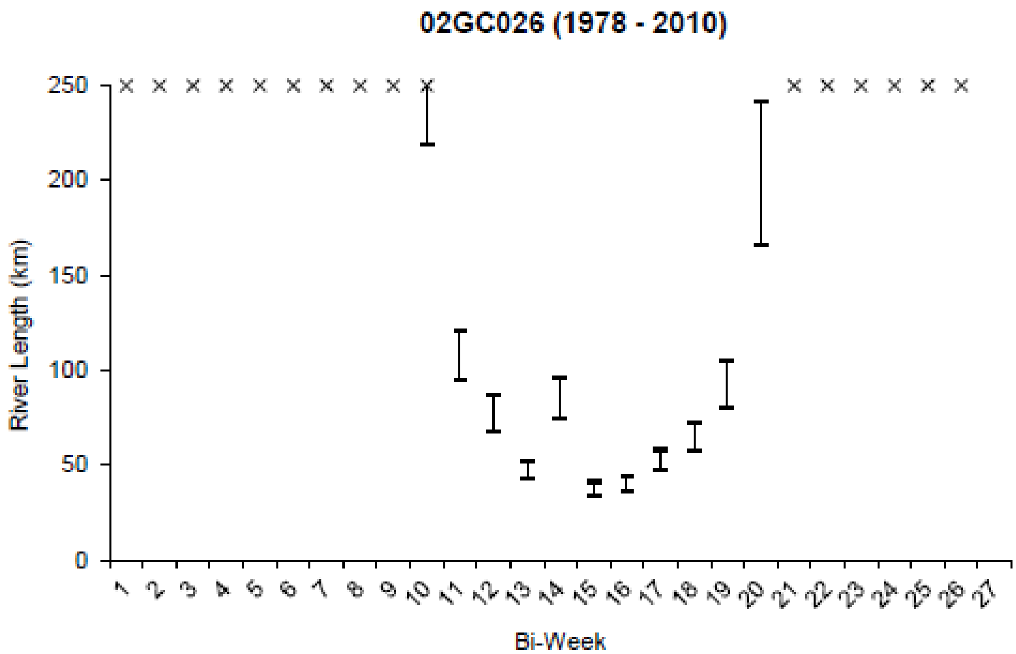


Figure A1-119. Gauging station 02GC022 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



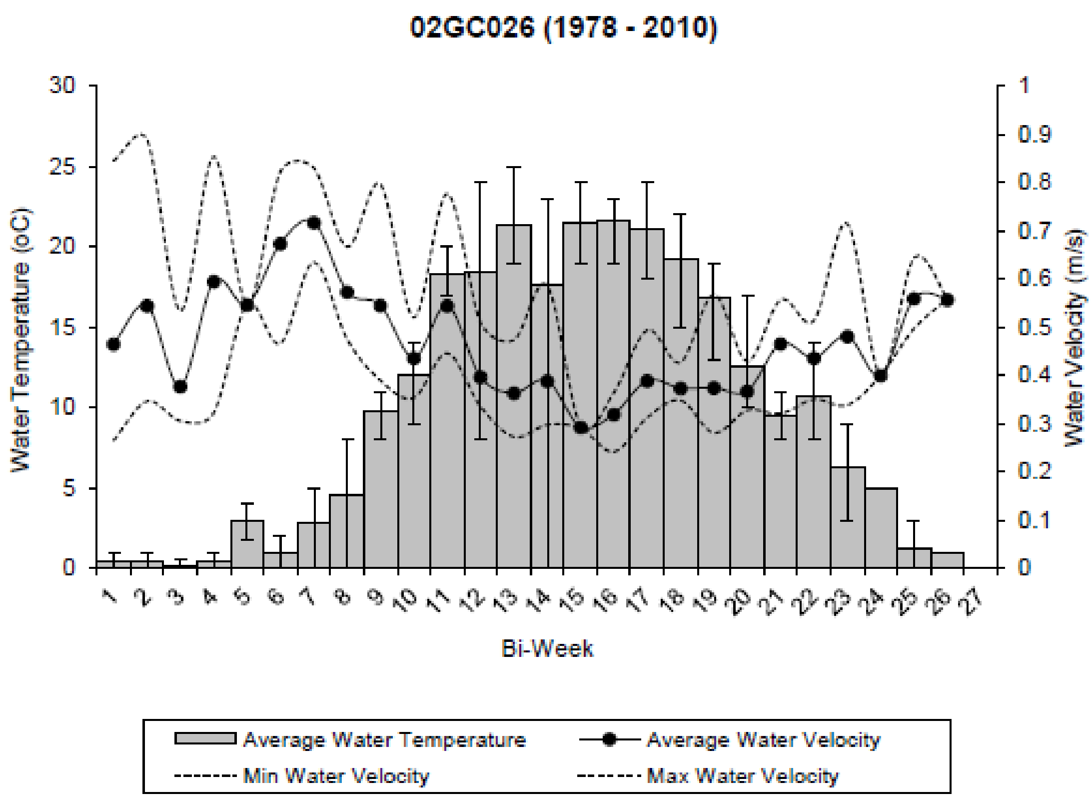
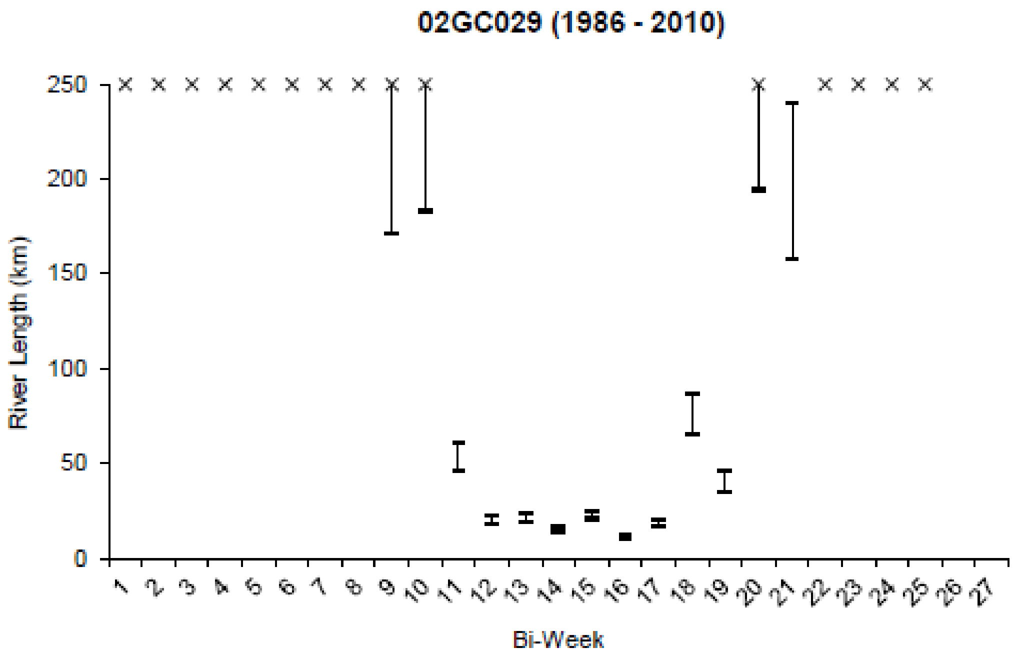


Figure A1-120. Gauging station 02GC026 data from 1978–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



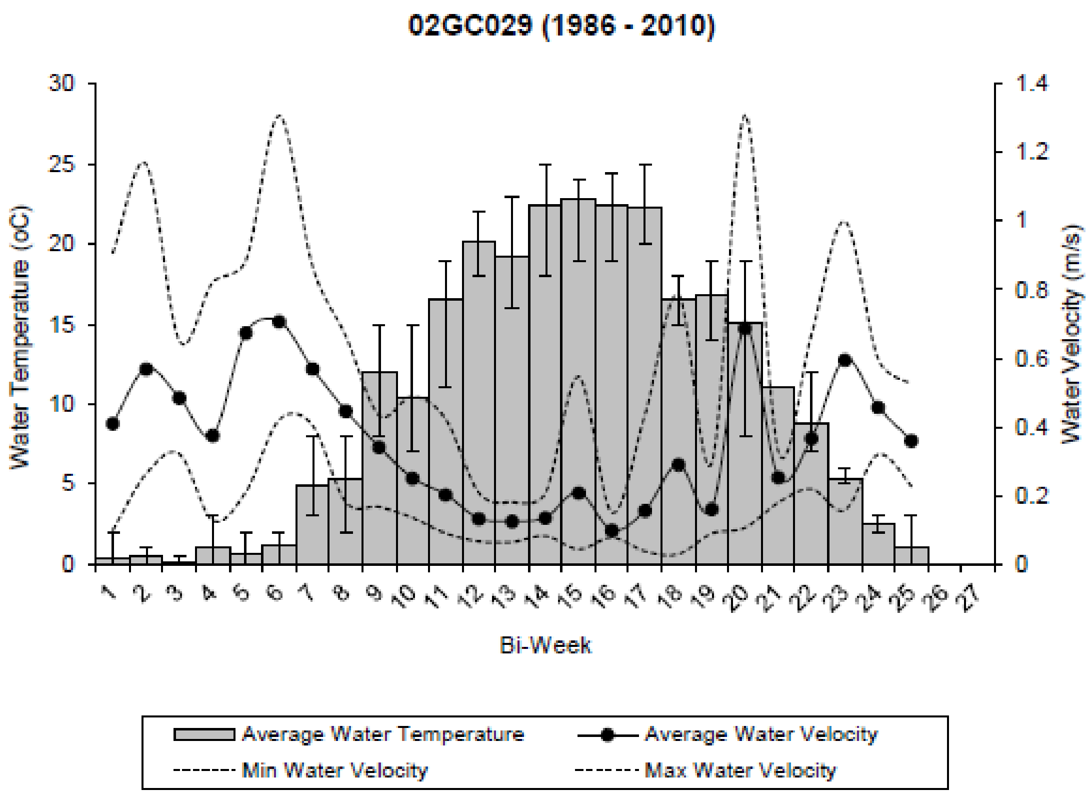
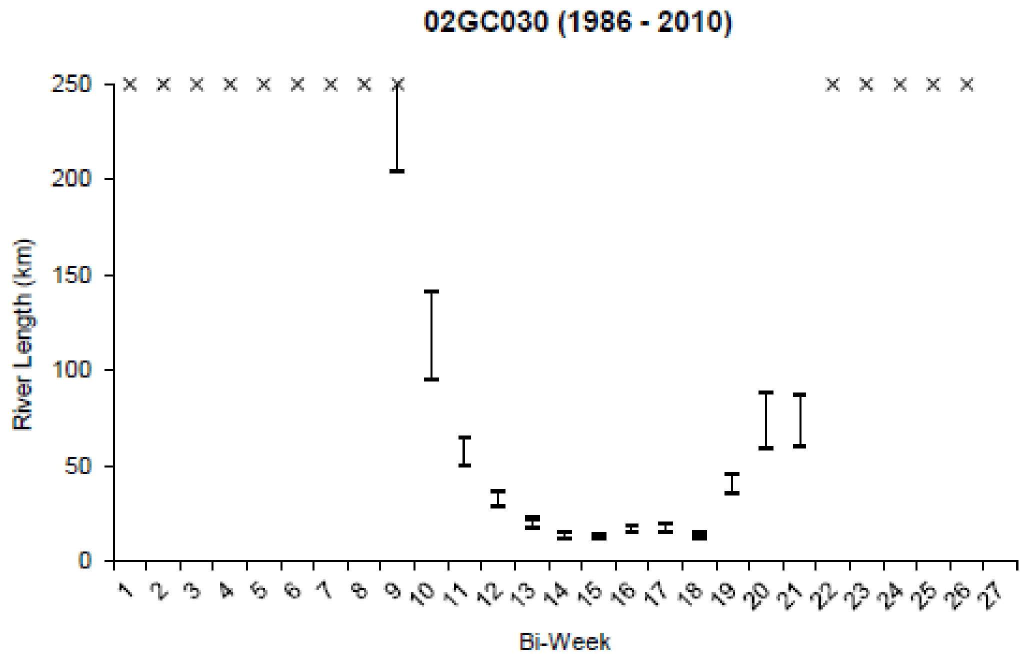


Figure A1-121. Gauging station 02GC029 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



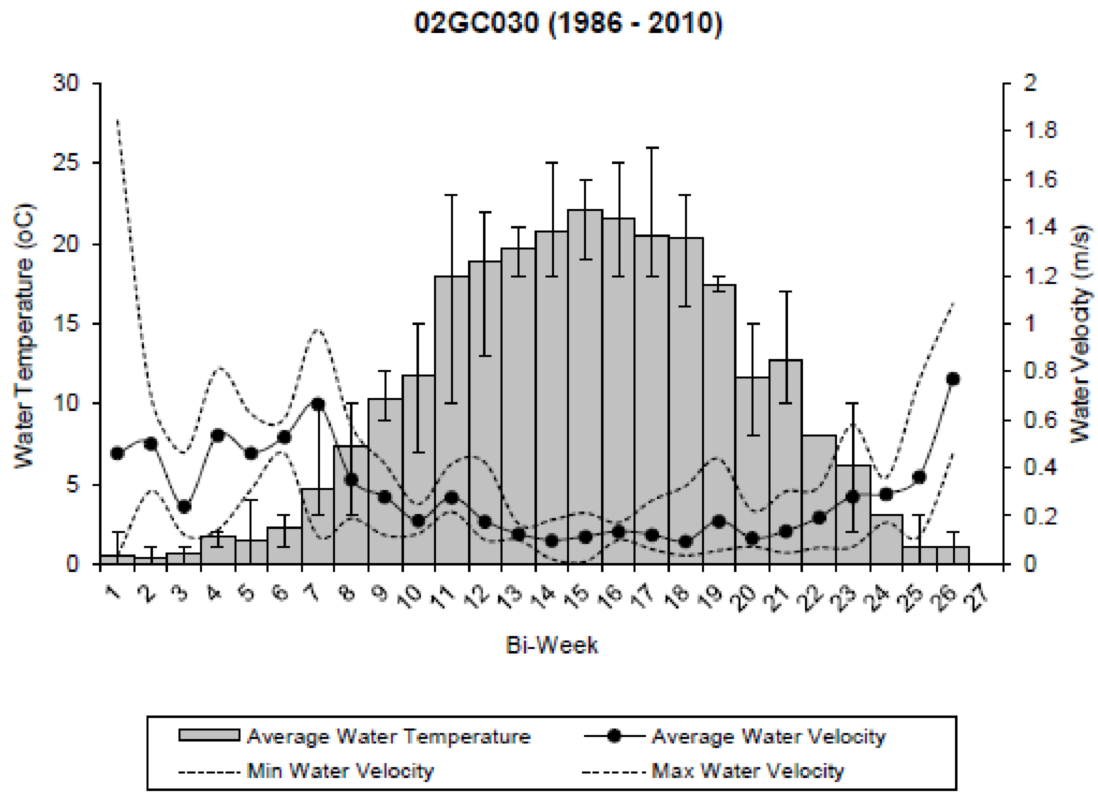
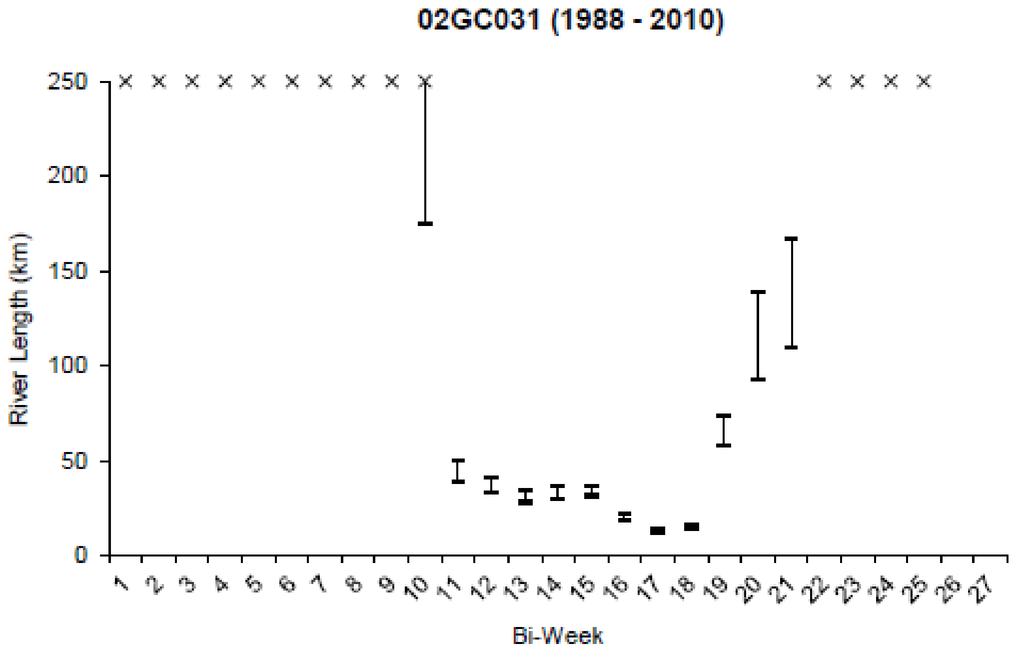


Figure A1-122. Gauging station 02GC030 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



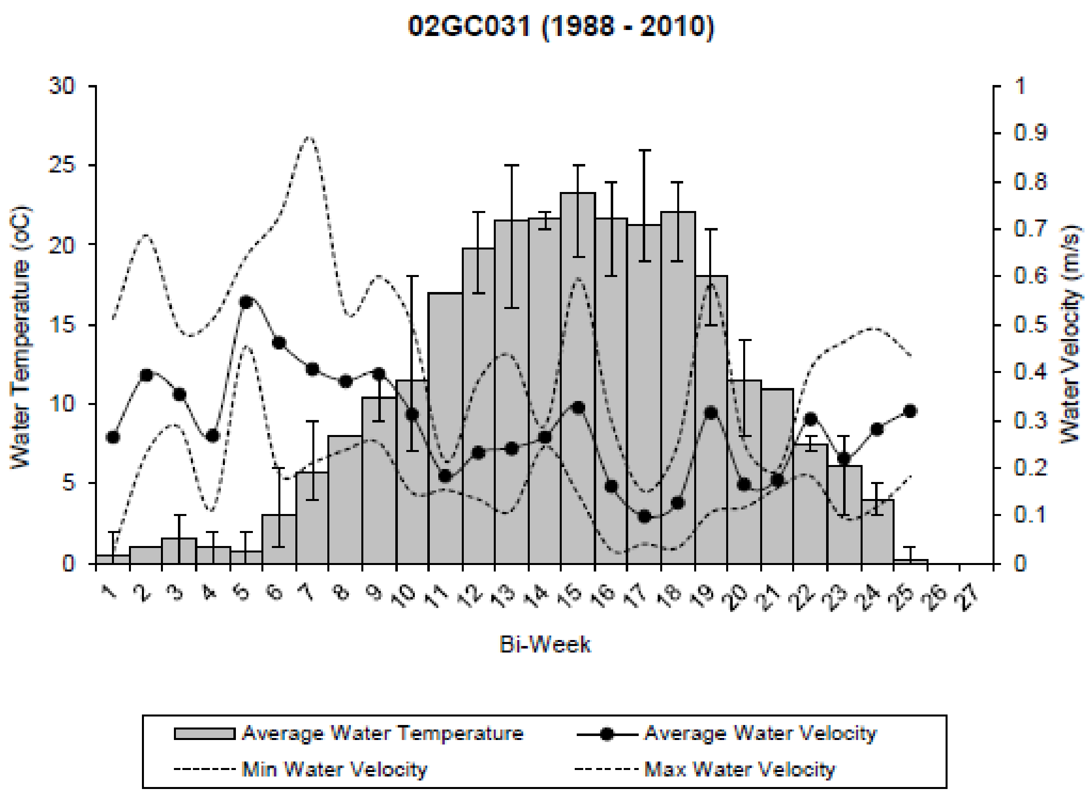


Figure A1-123. Gauging station 02GC031 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

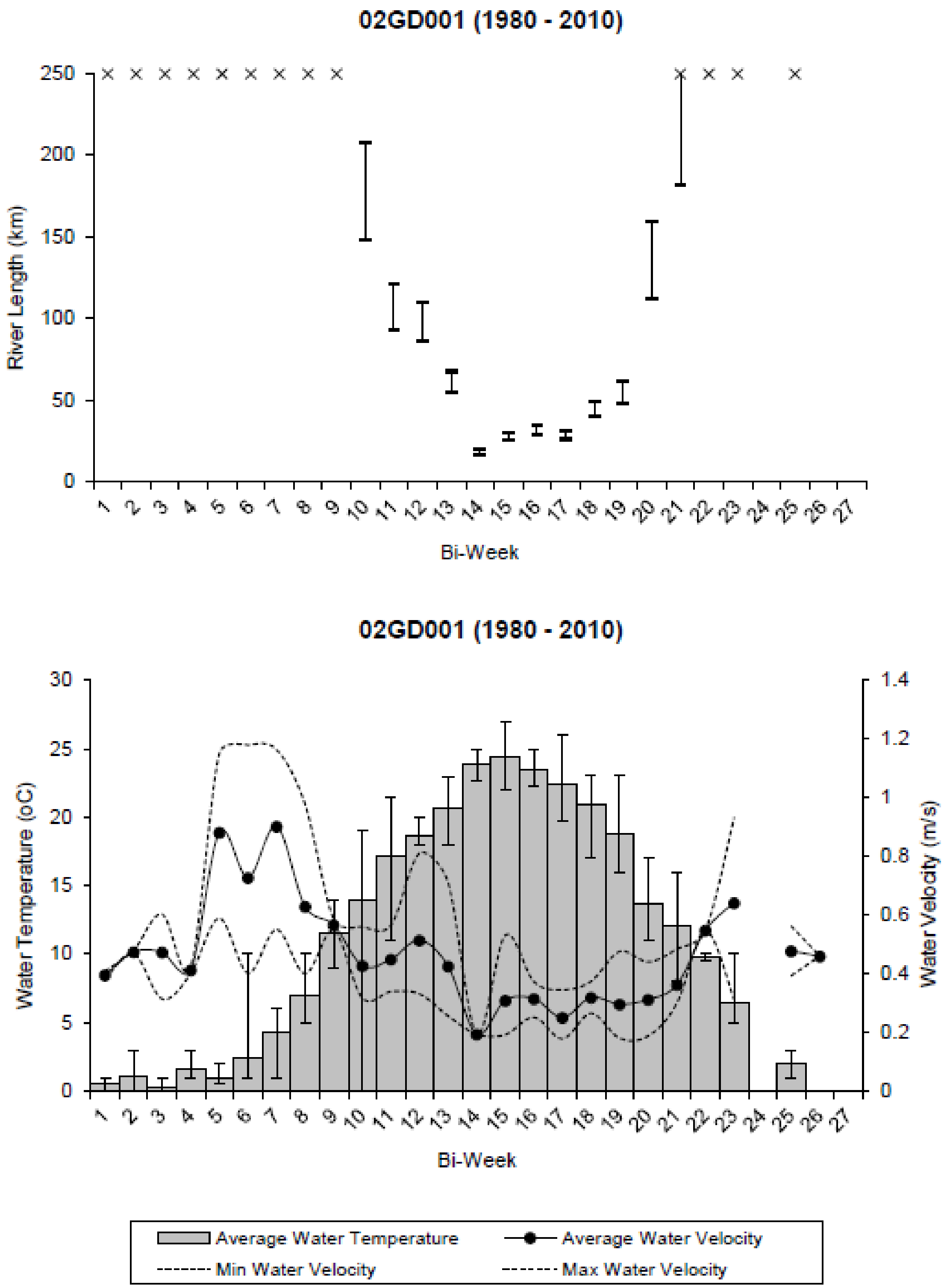
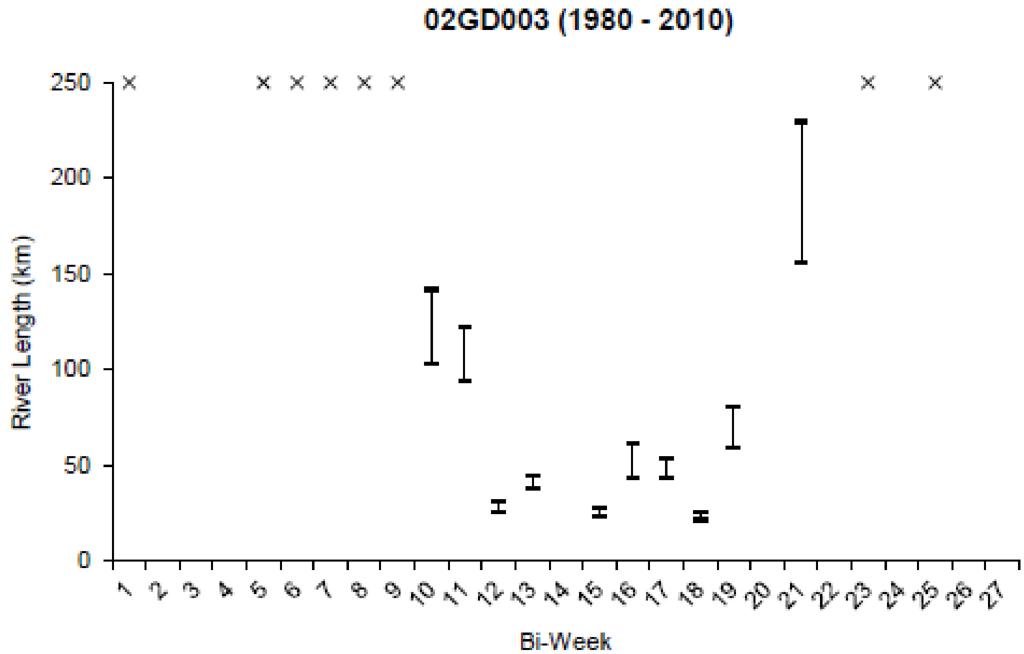


Figure A1-124. Gauging station 02GD001 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



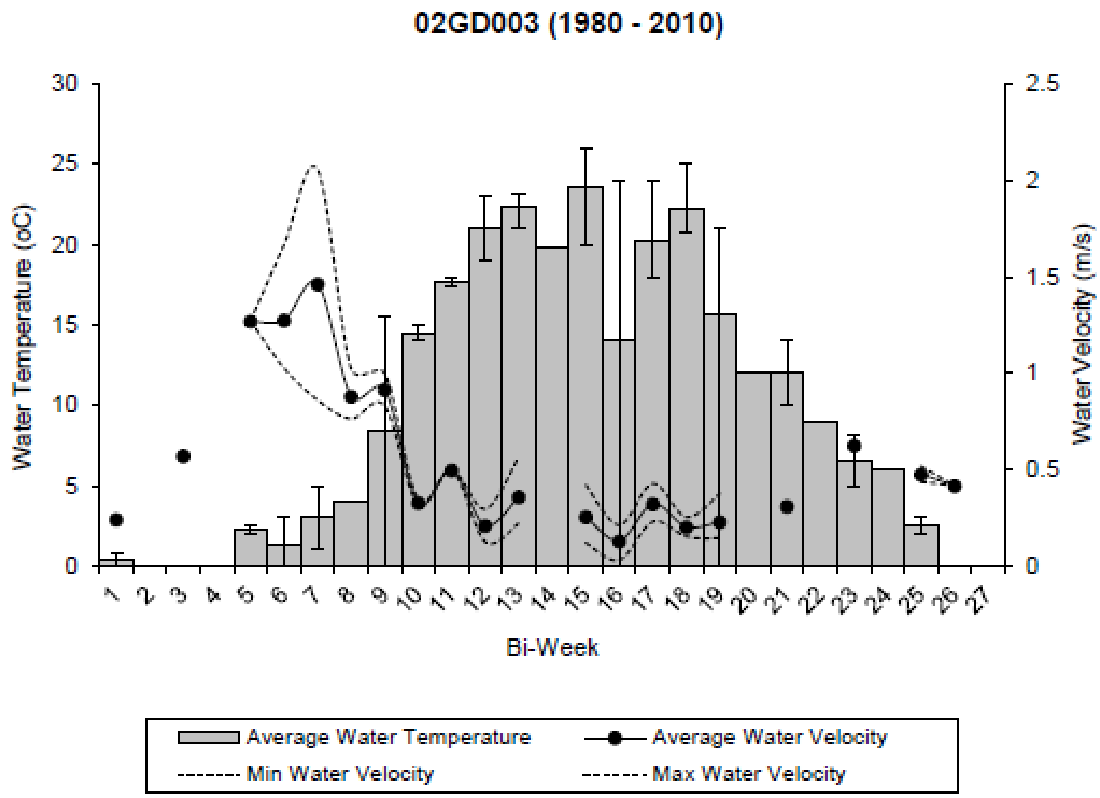


Figure A1-125. Gauging station 02GD003 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

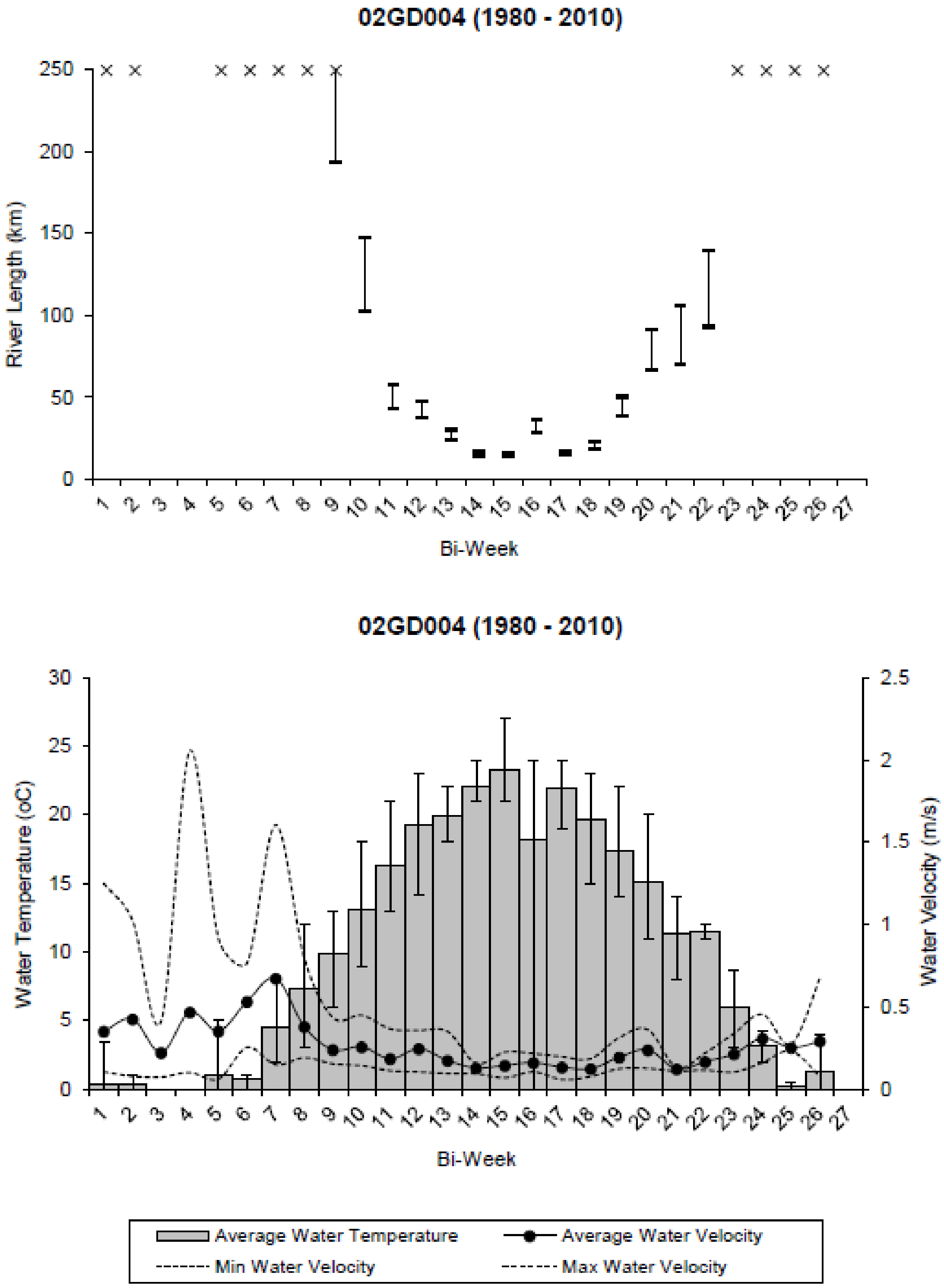
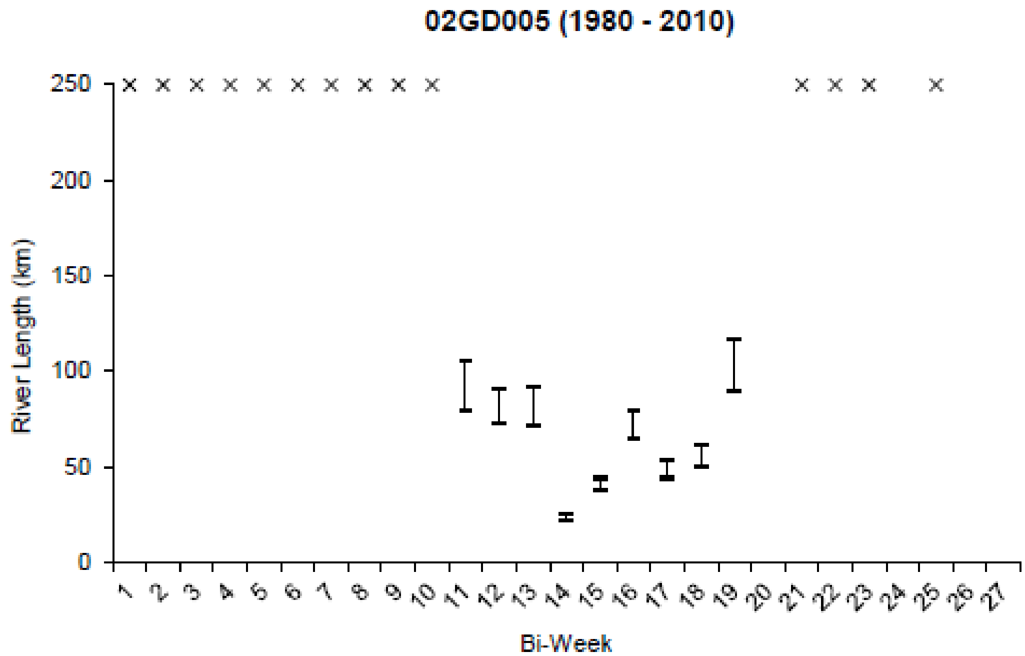


Figure A1-126. Gauging station 02GD004 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



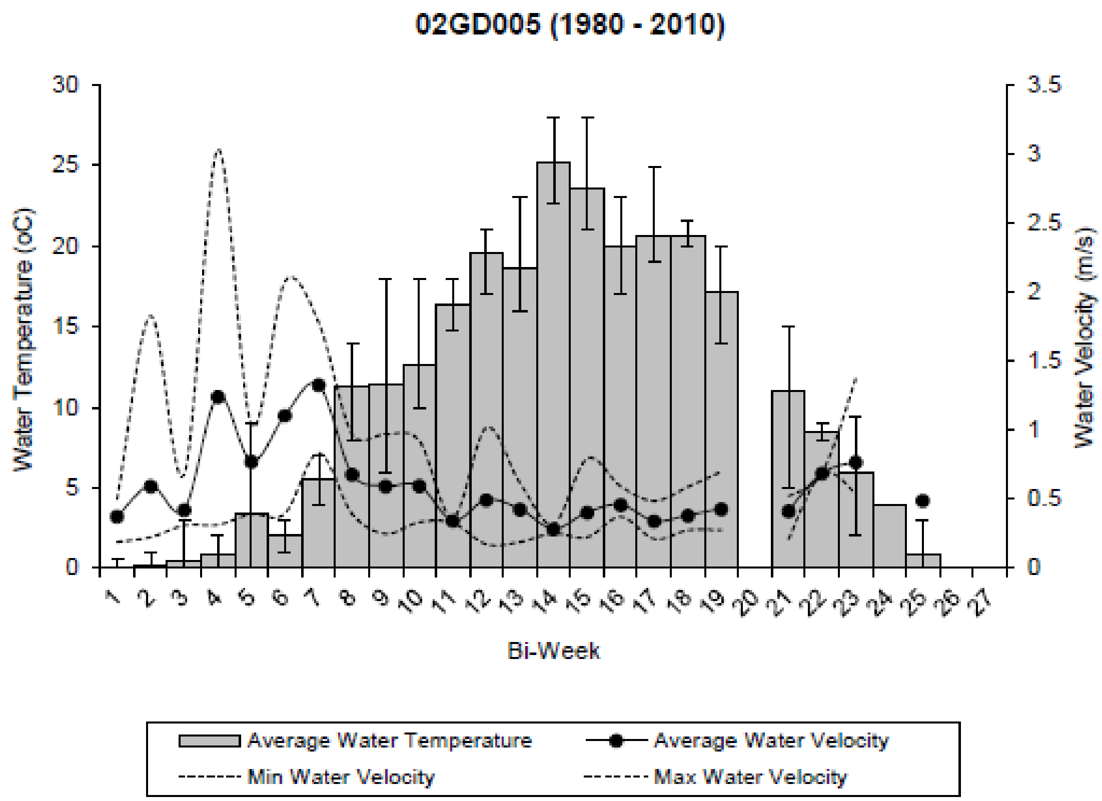
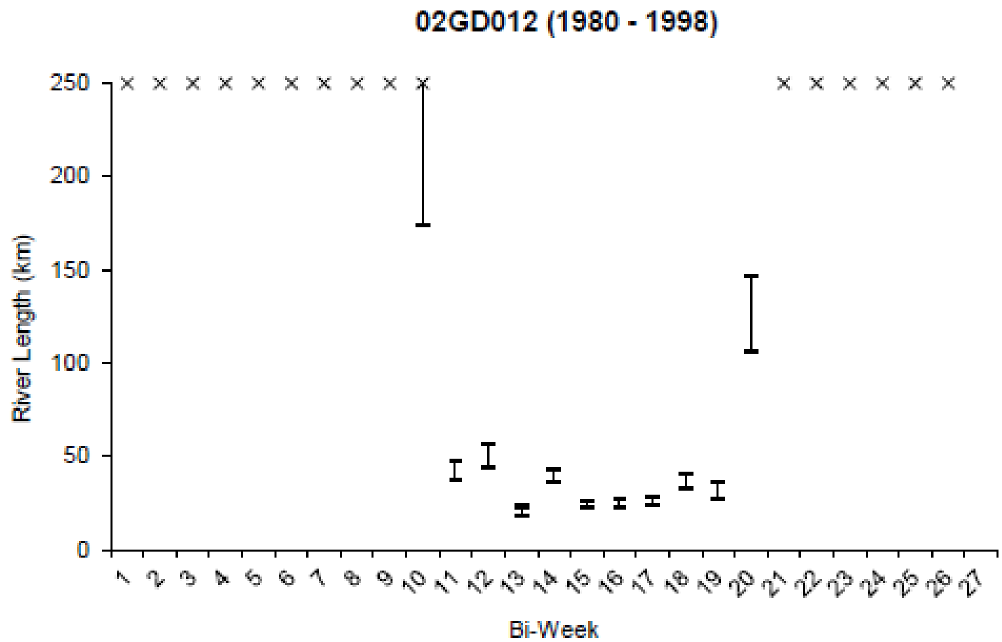


Figure A1-127. Gauging station 02GD005 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



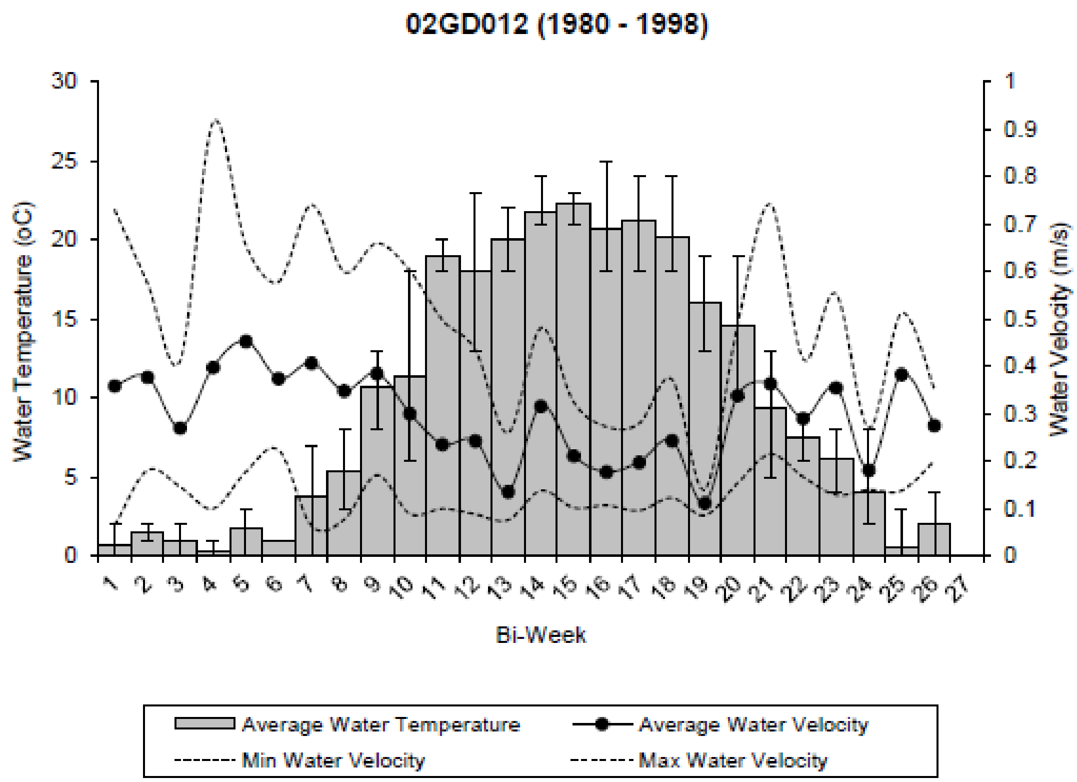
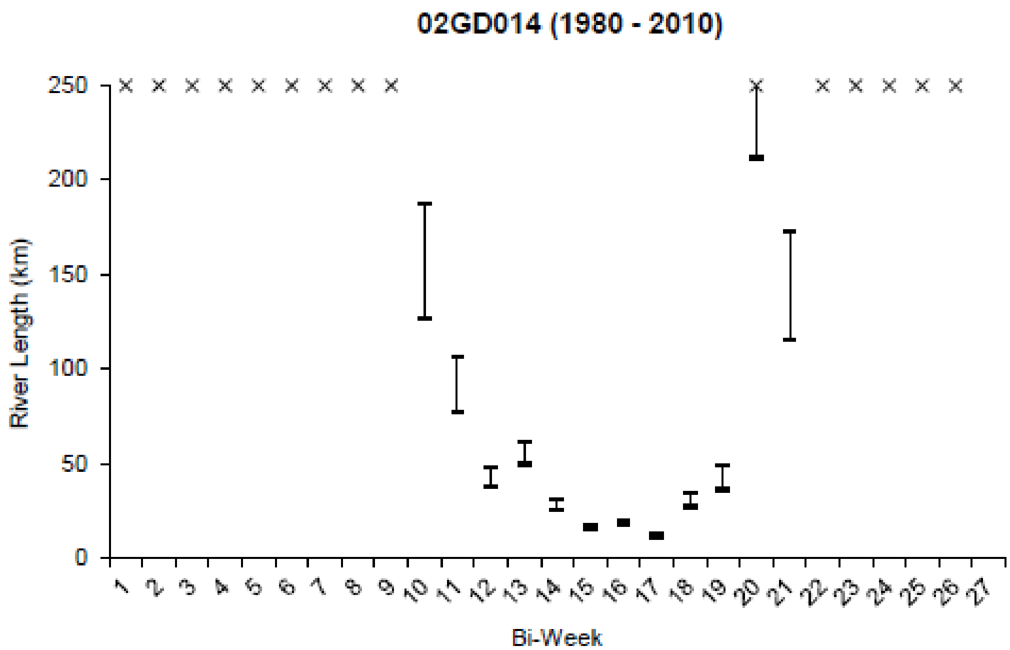


Figure A1-128. Gauging station 02GD012 data from 1980–1998. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



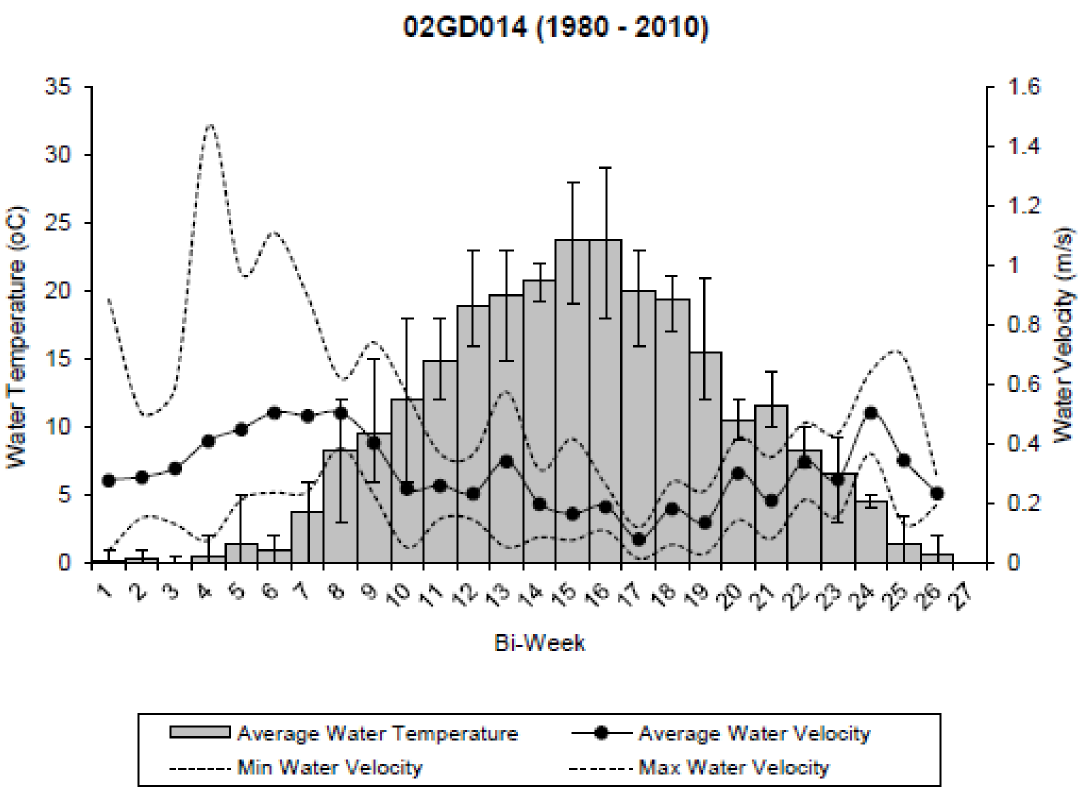
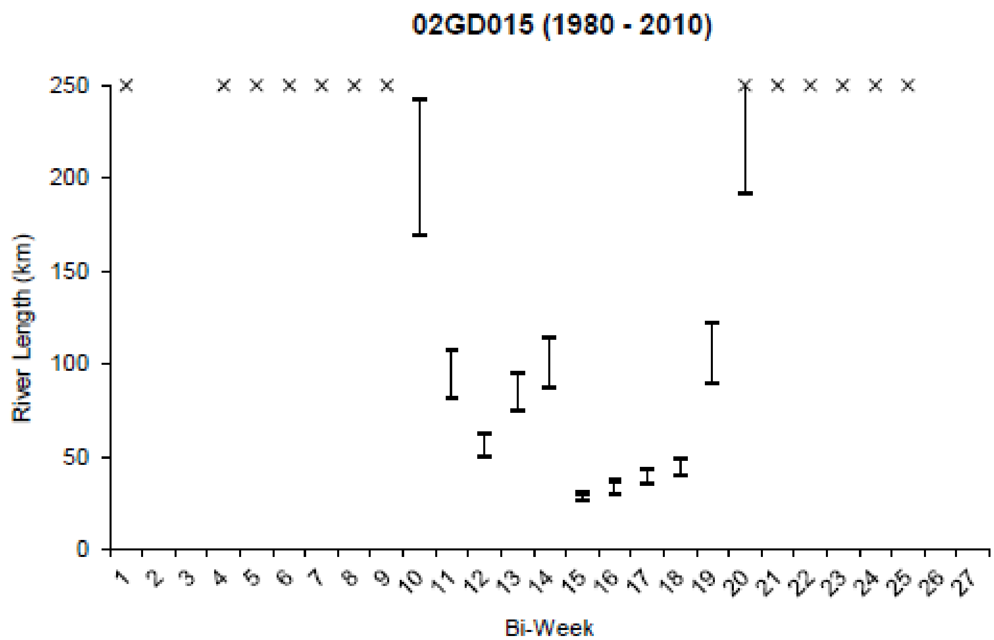


Figure A1-129. Gauging station 02GD014 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



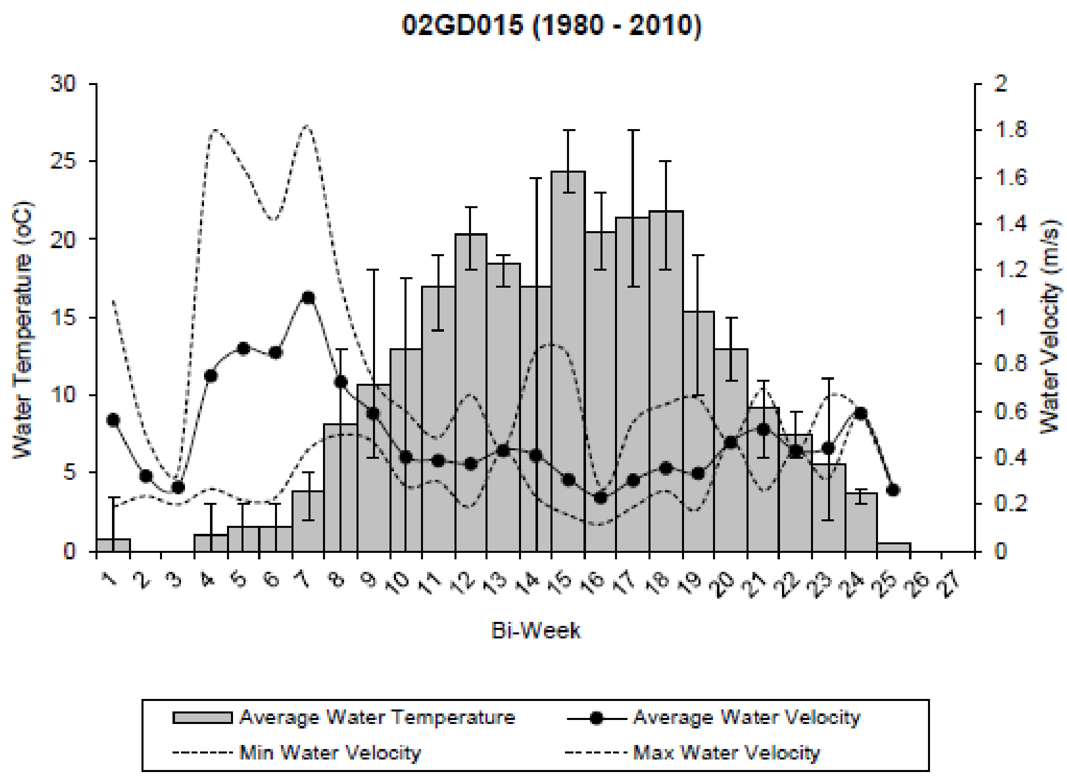
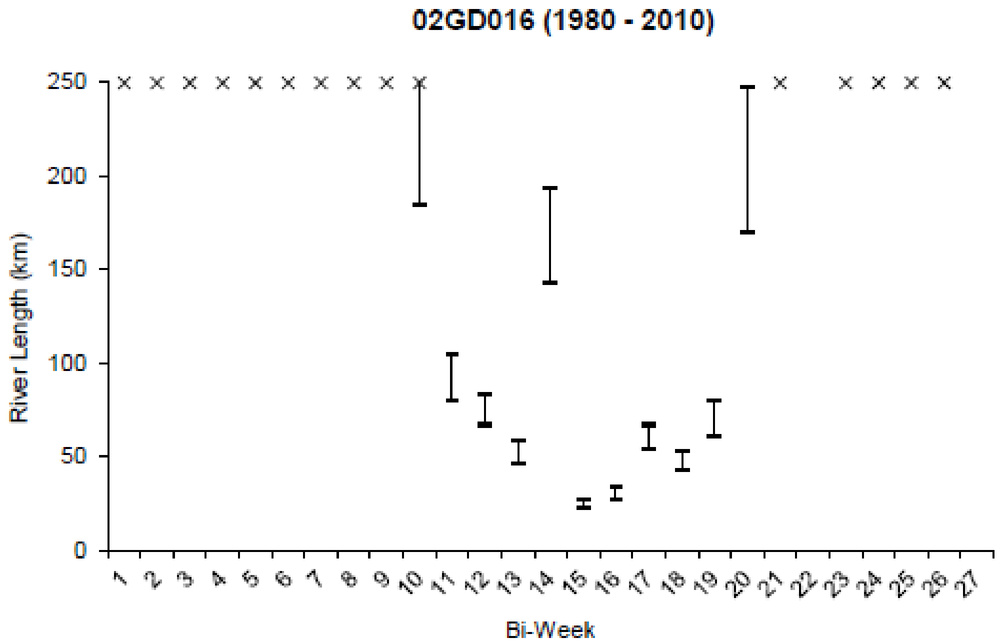


Figure A1-130. Gauging station 02GD015 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



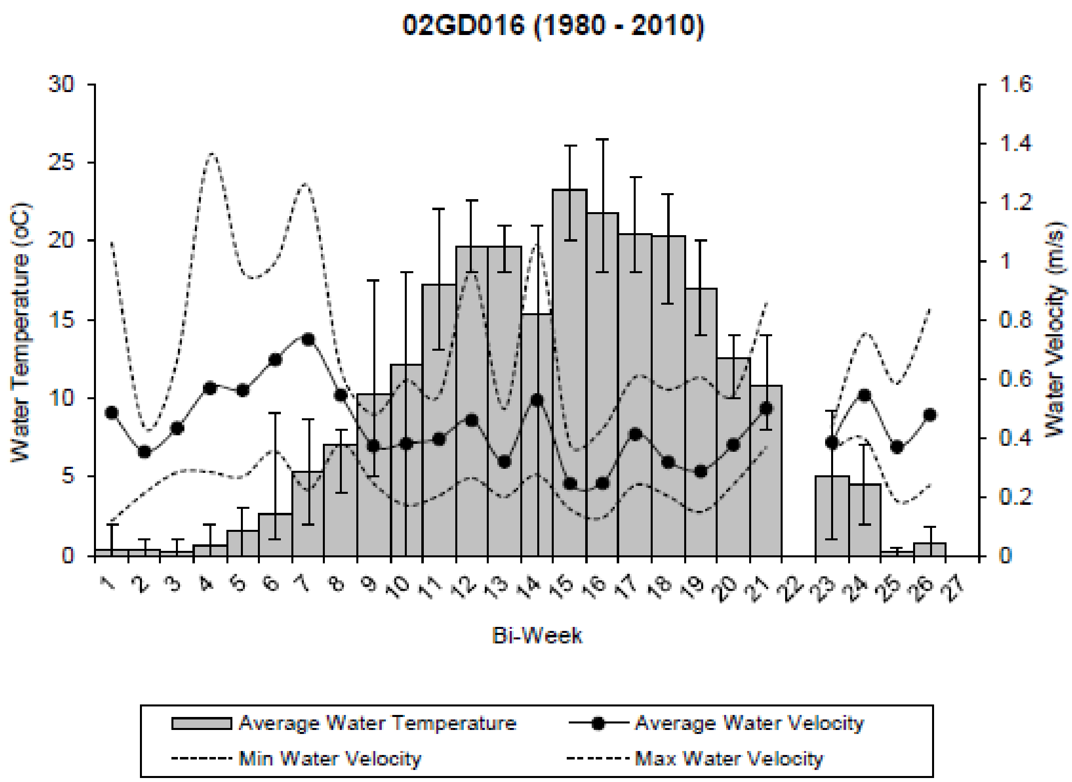
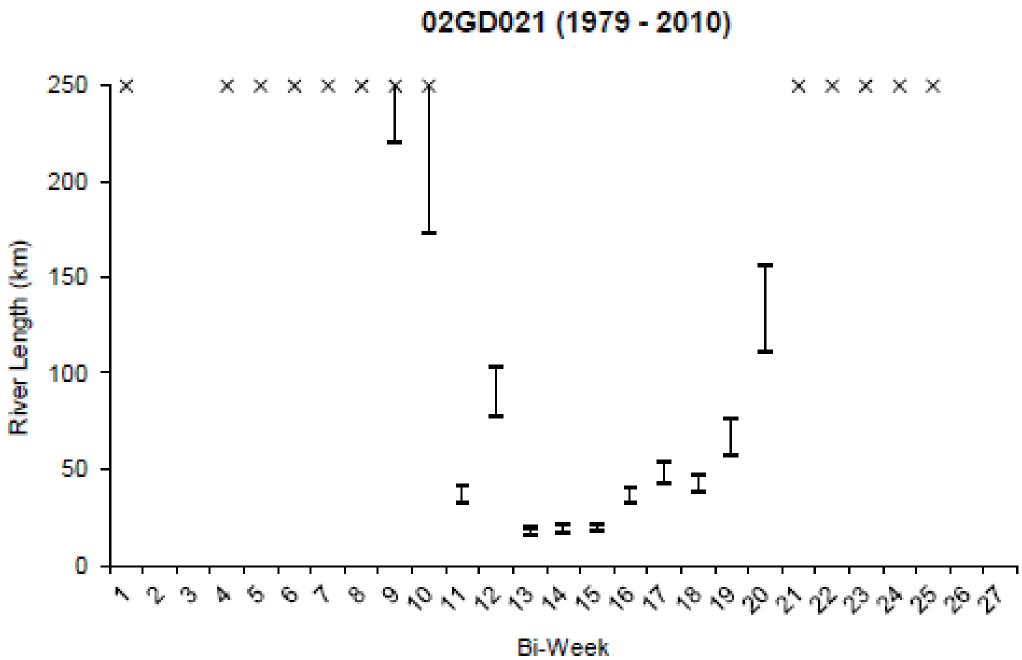


Figure A1-131. Gauging station 02GD016 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



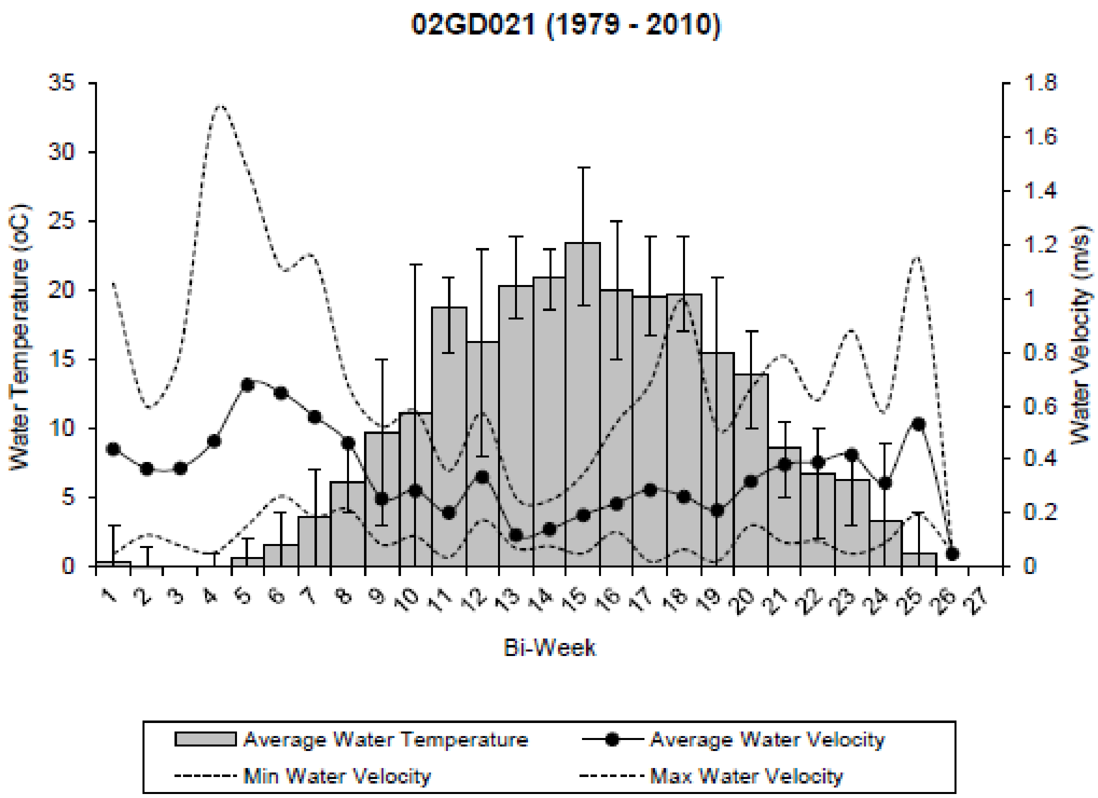
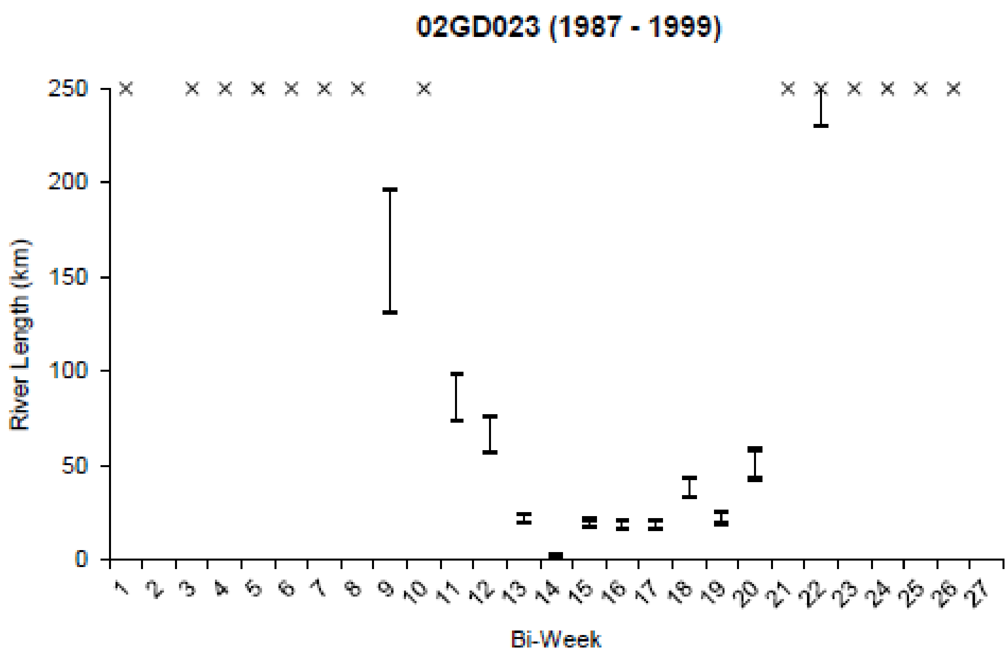


Figure A1-132. Gauging station 02GD021 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



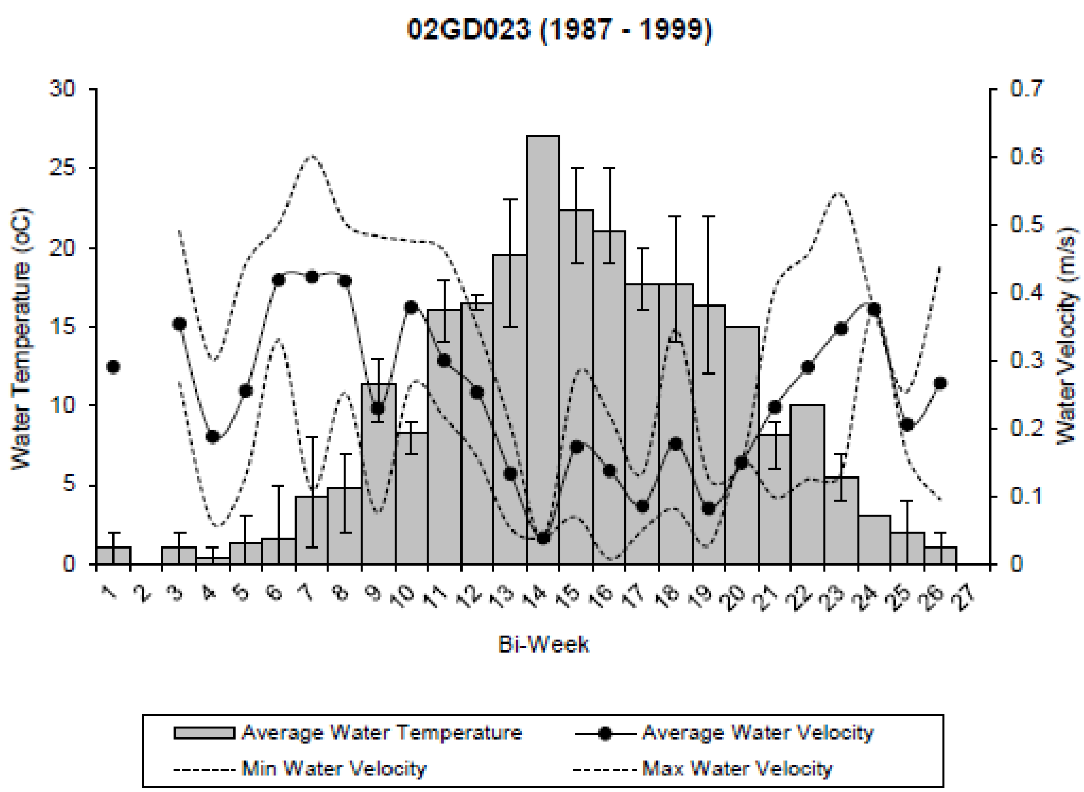
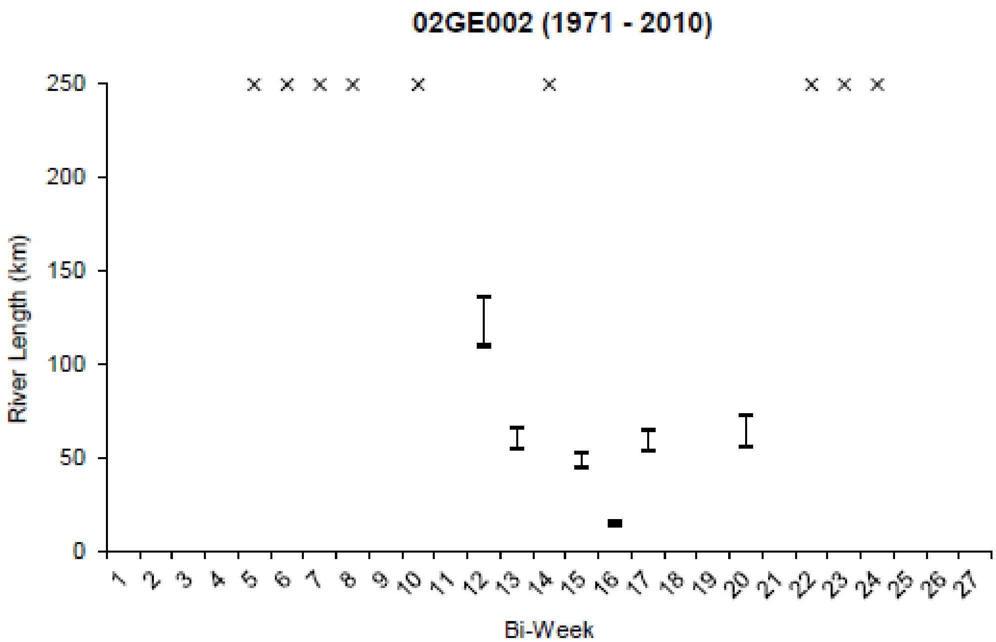


Figure A1-133. Gauging station 02GD023 data from 1987–1999. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



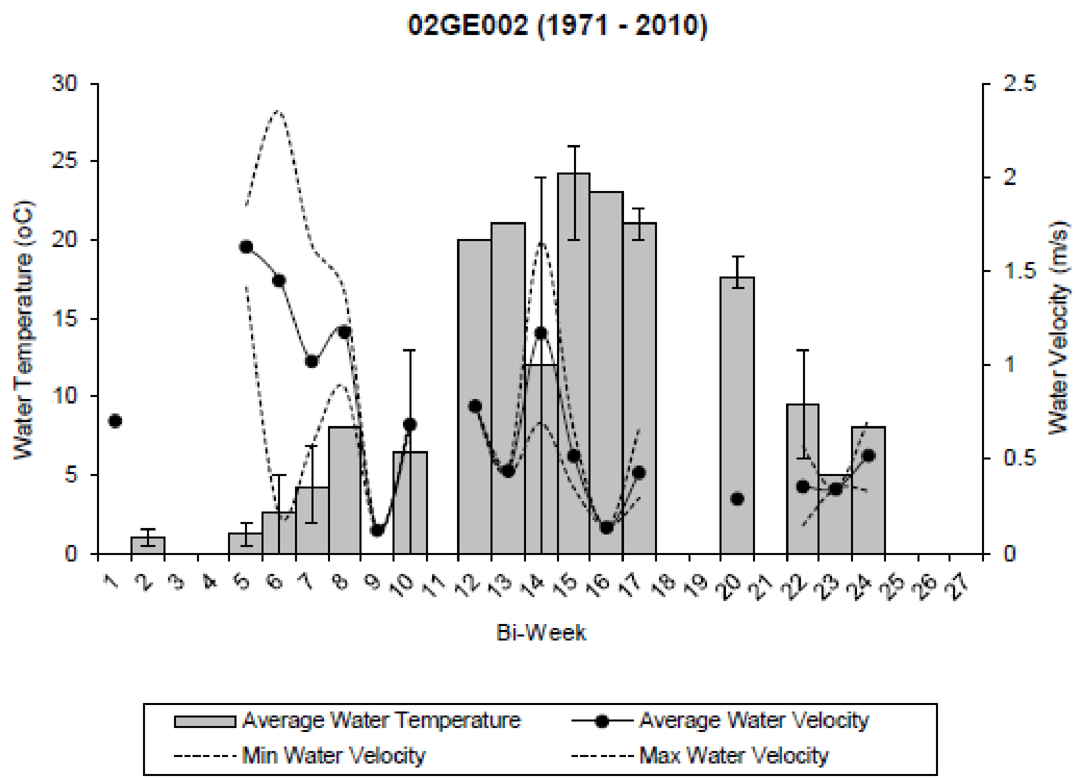
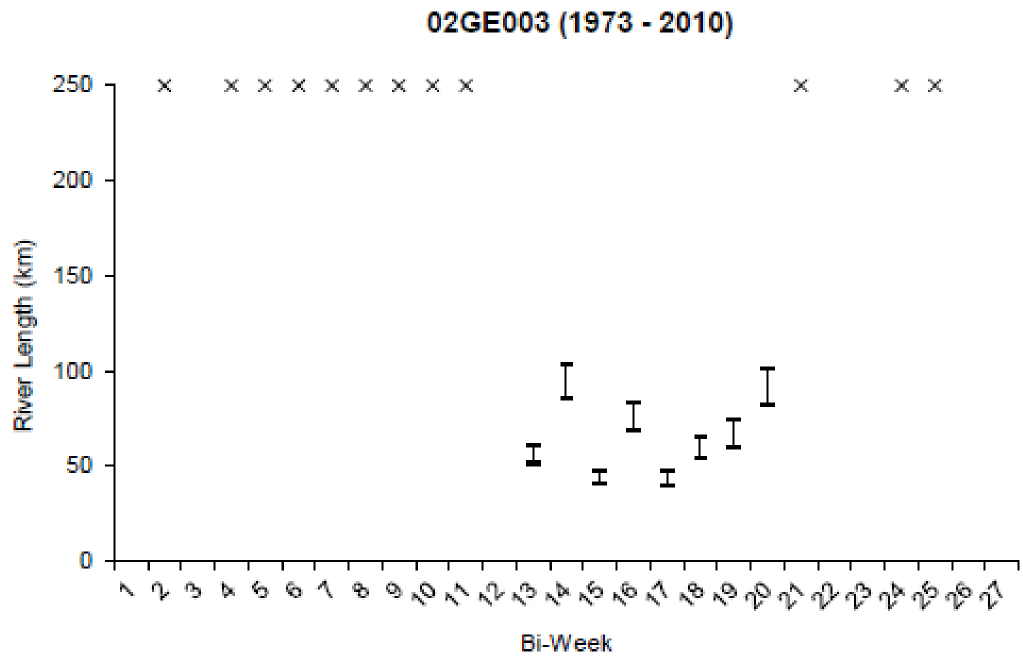


Figure A1-134. Gauging station 02GE002 data from 1971–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



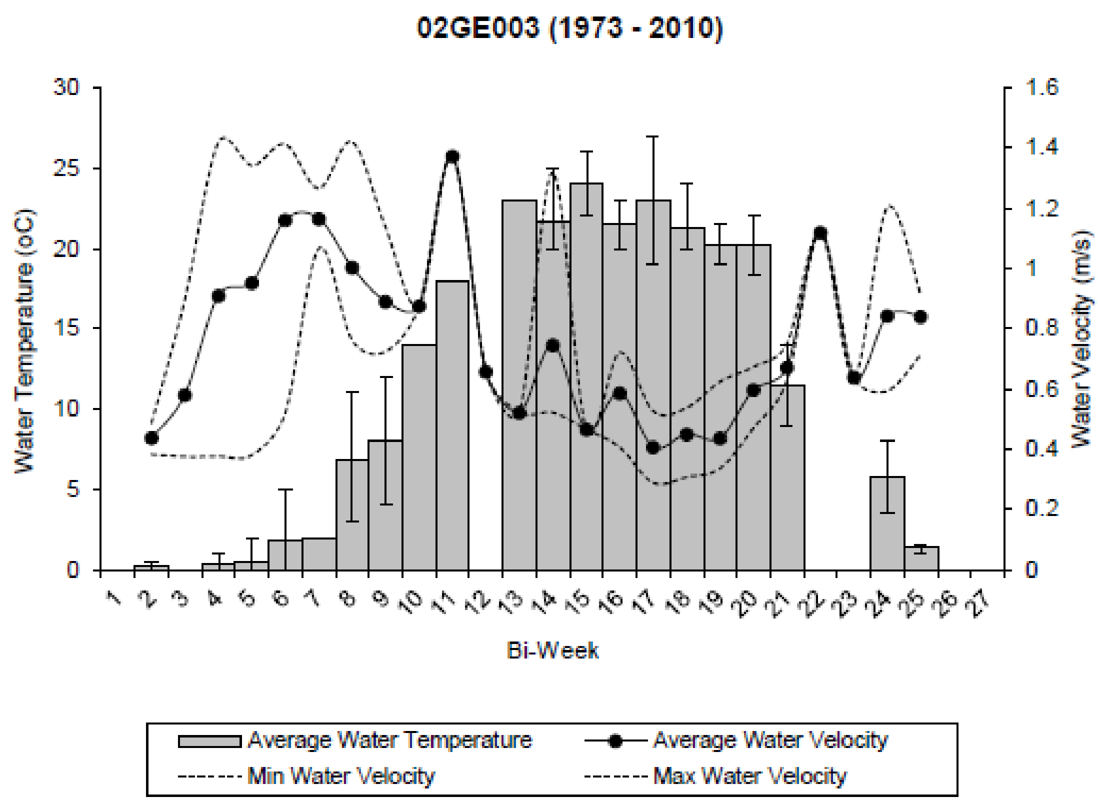
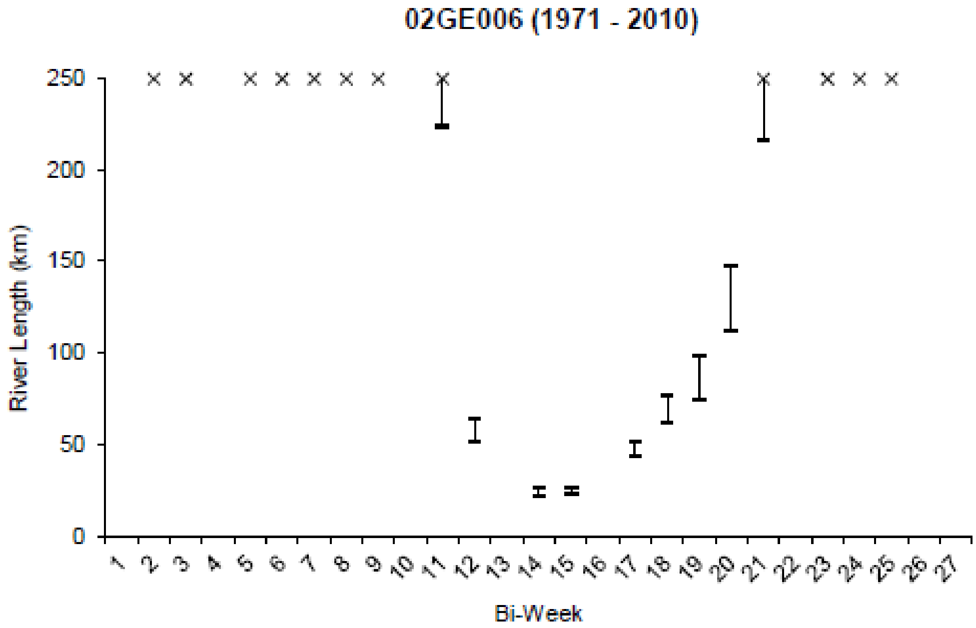


Figure A1-135. Gauging station 02GE003 data from 1973–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



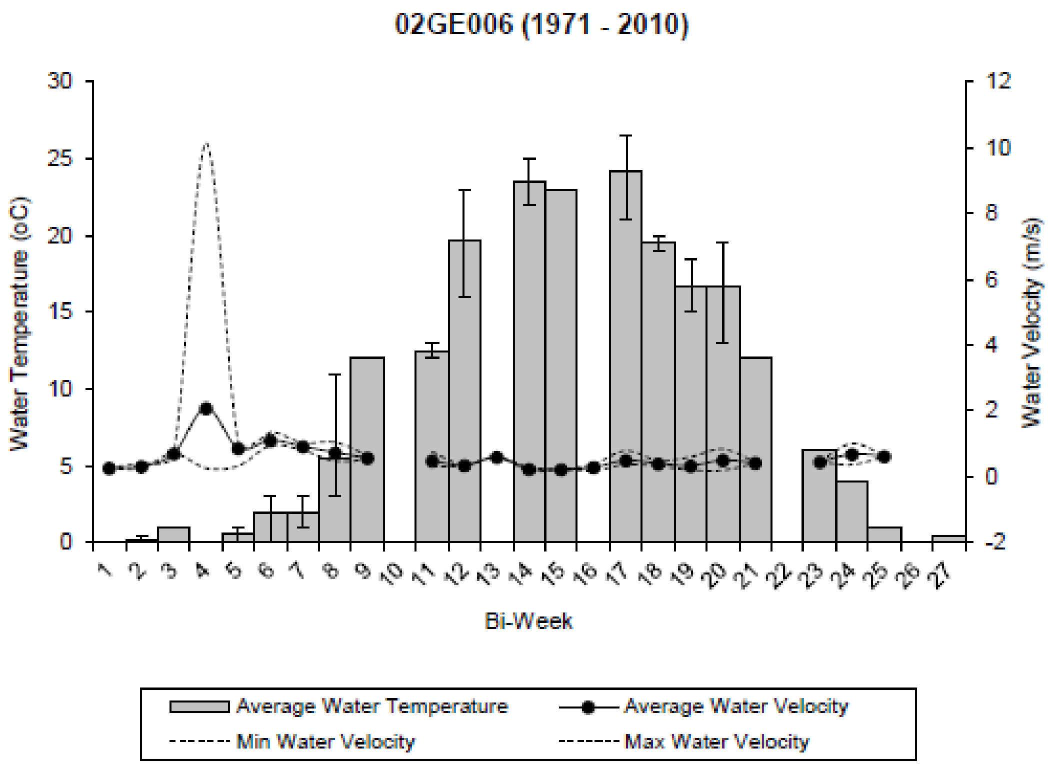
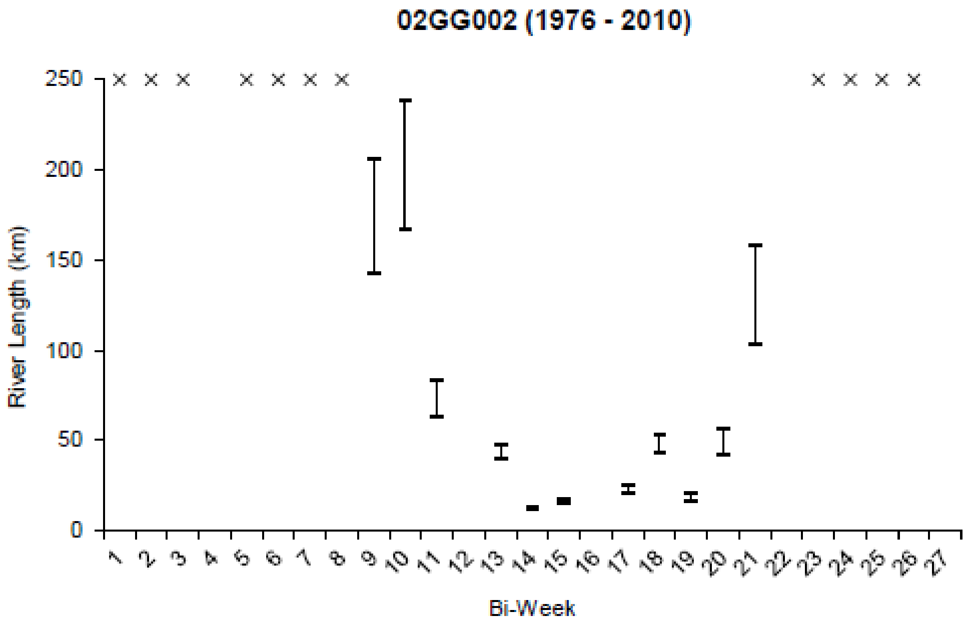


Figure A1-136. Gauging station 02GE006 data from 1971–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



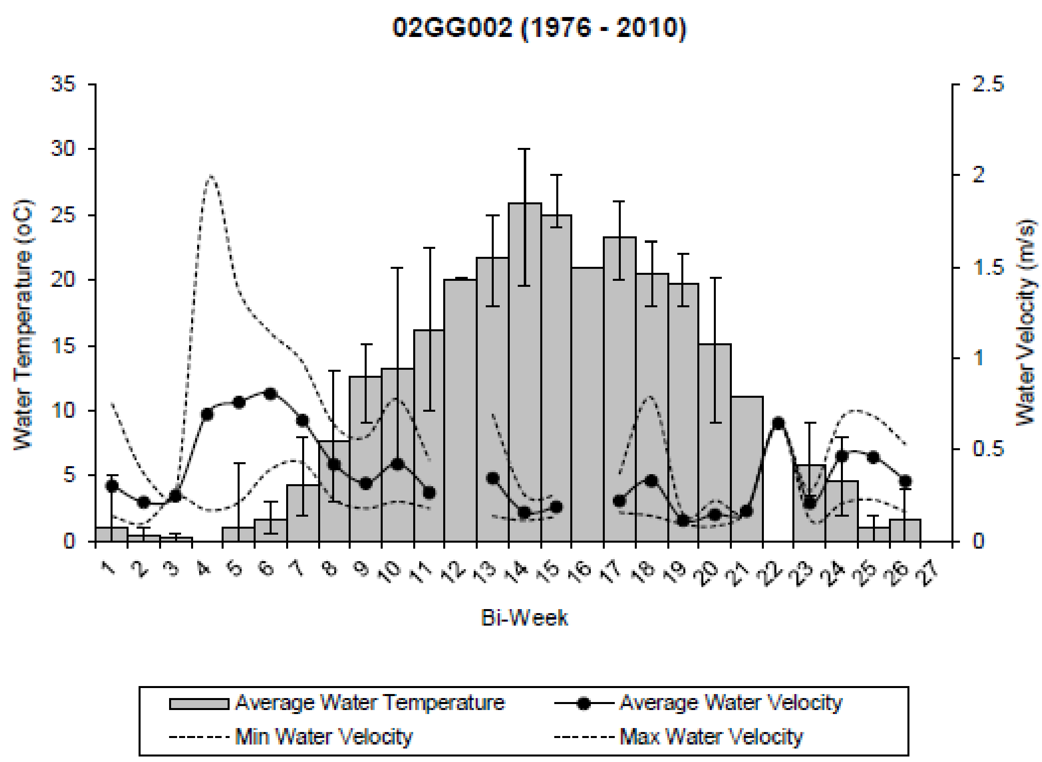
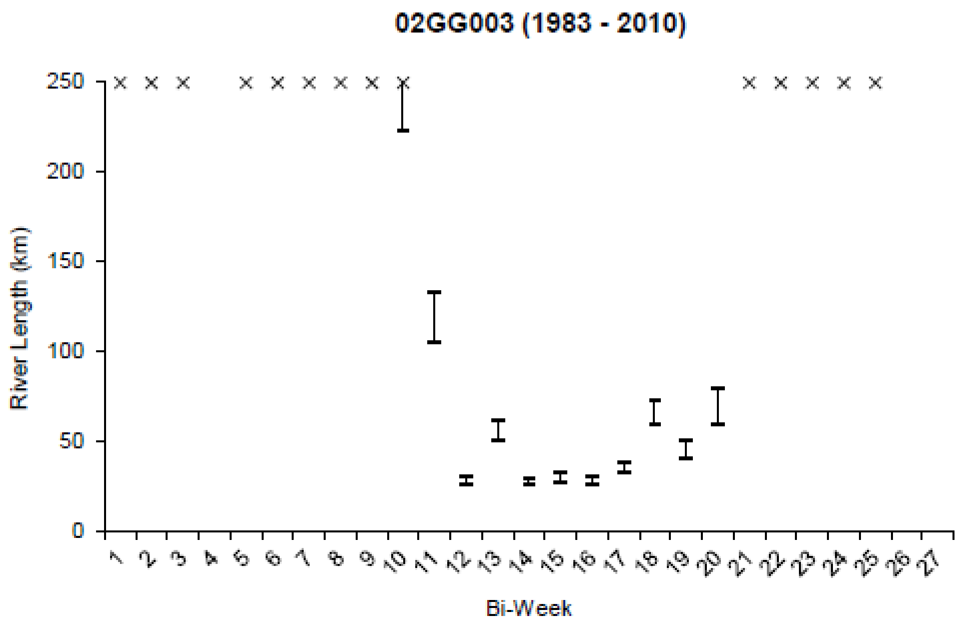


Figure A1-137. Gauging station 02GG002 data from 1976–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



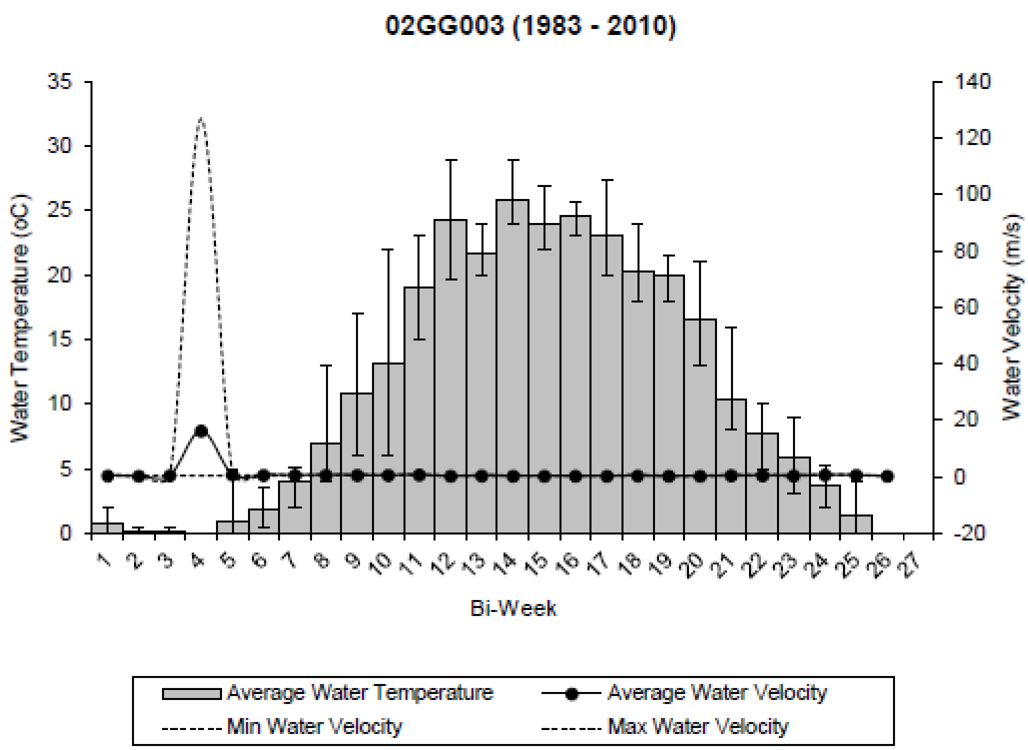
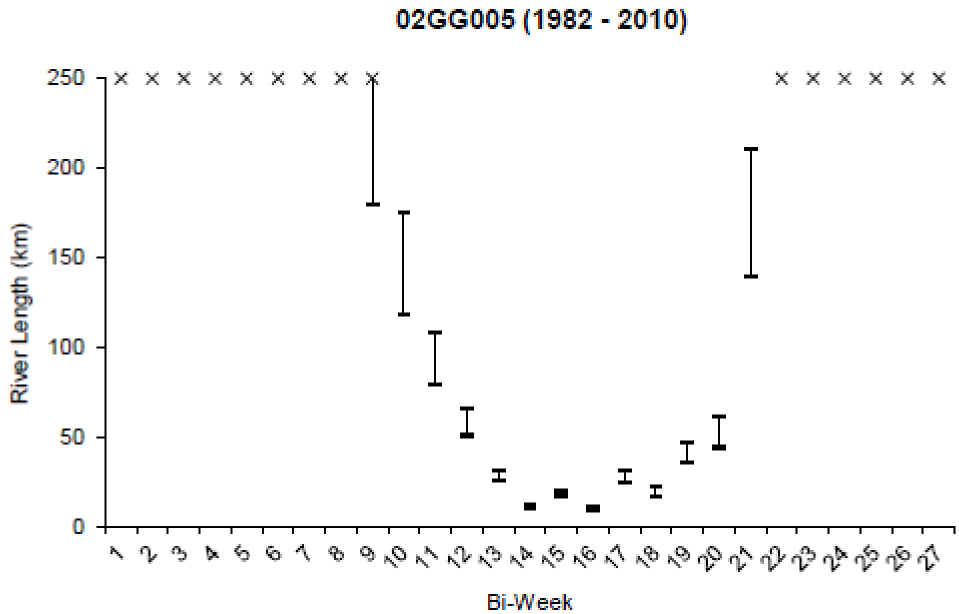


Figure A1-138. Gauging station 02GG003 data from 1983–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



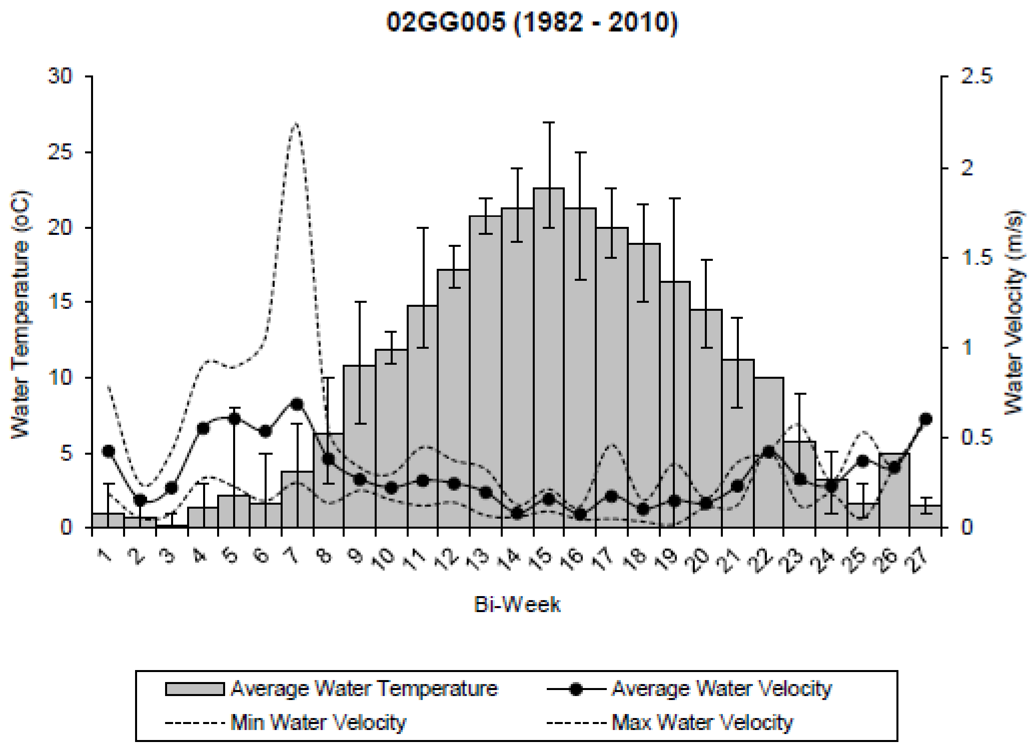
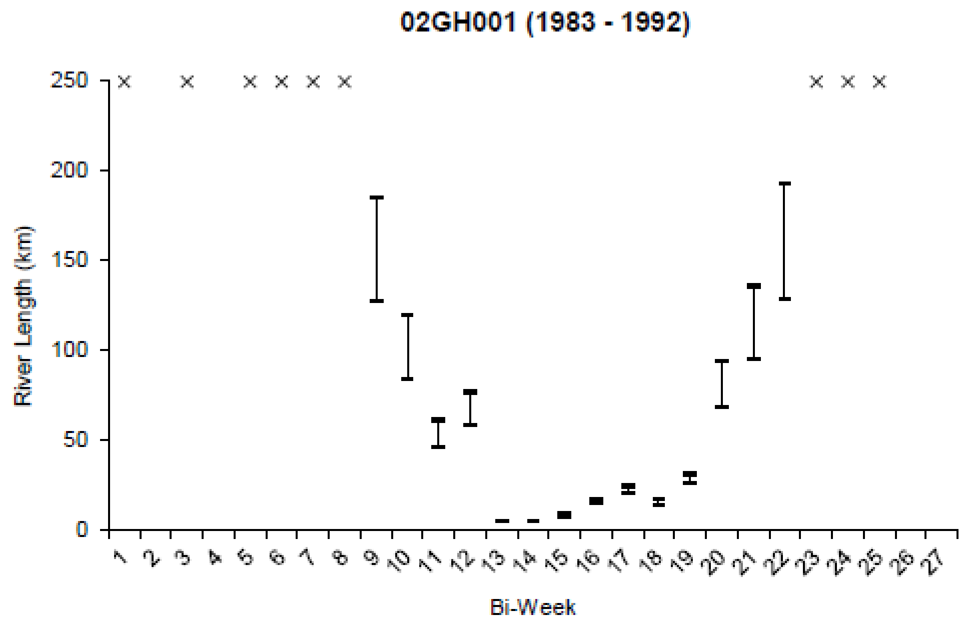


Figure A1-139. Gauging station 02GG005 data from 1982–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



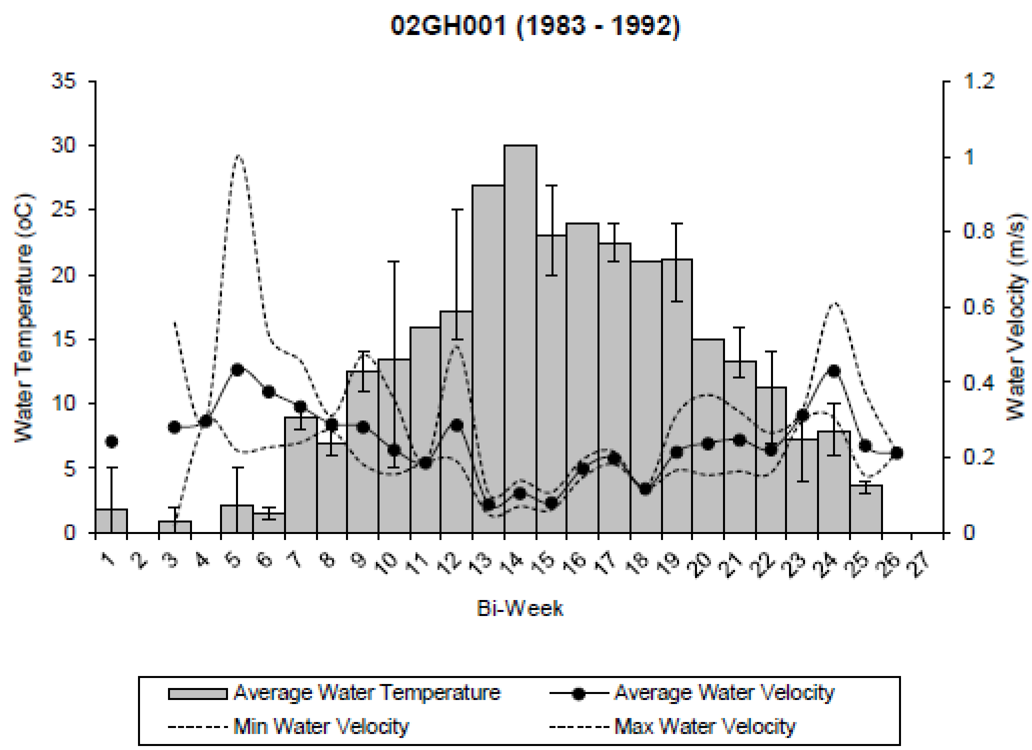
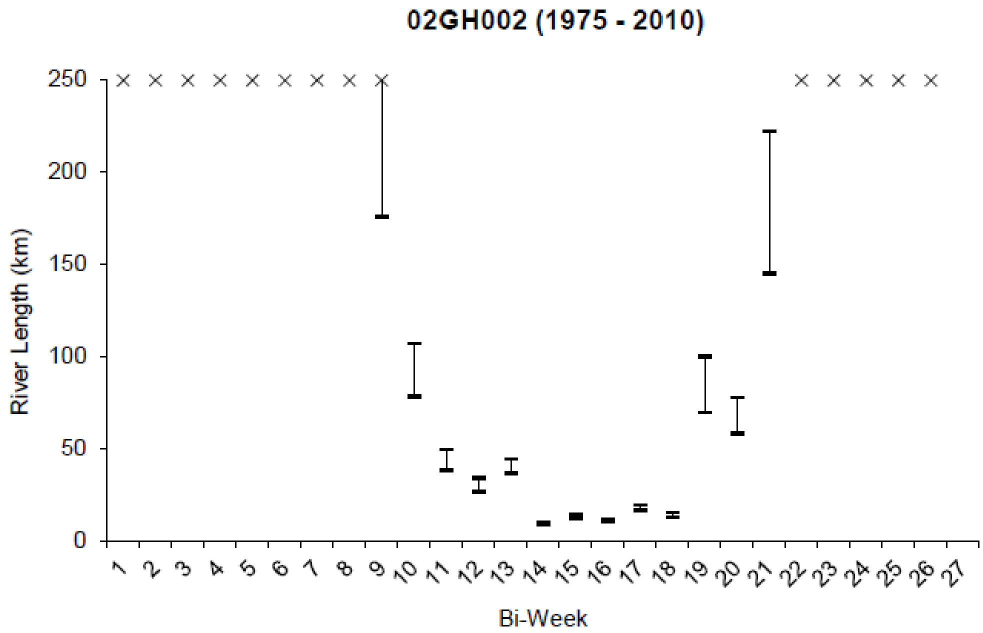


Figure A1-140. Gauging station 02GH001 data from 1983–1992. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



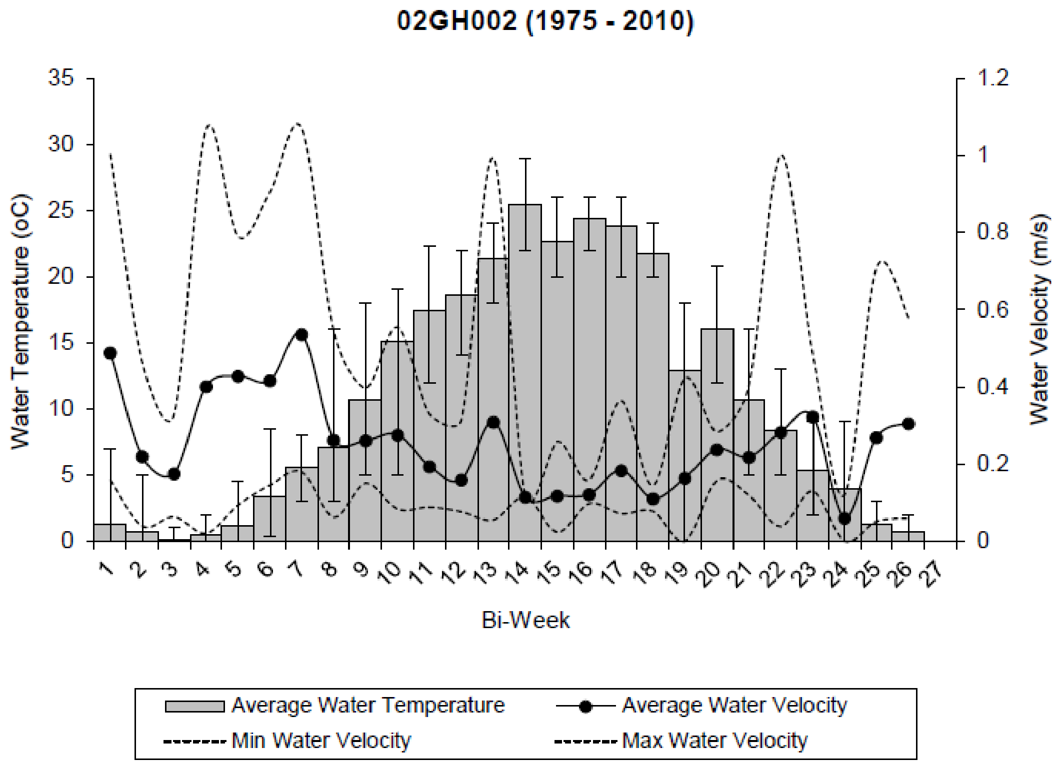


Figure A1-141. Gauging station 02GH002 data from 1975–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

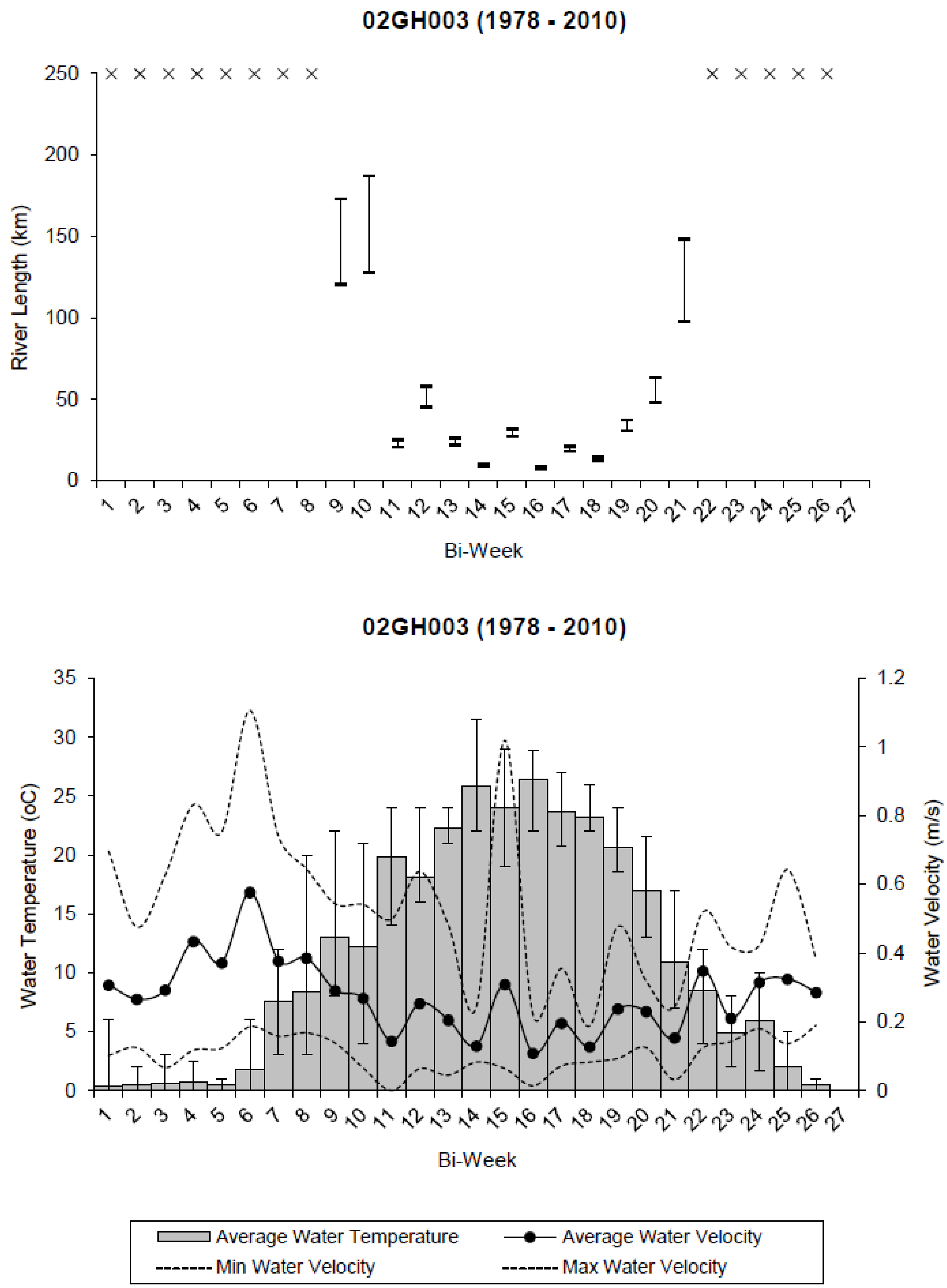


Figure A1-142. Gauging station 02GH003 data from 1978–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

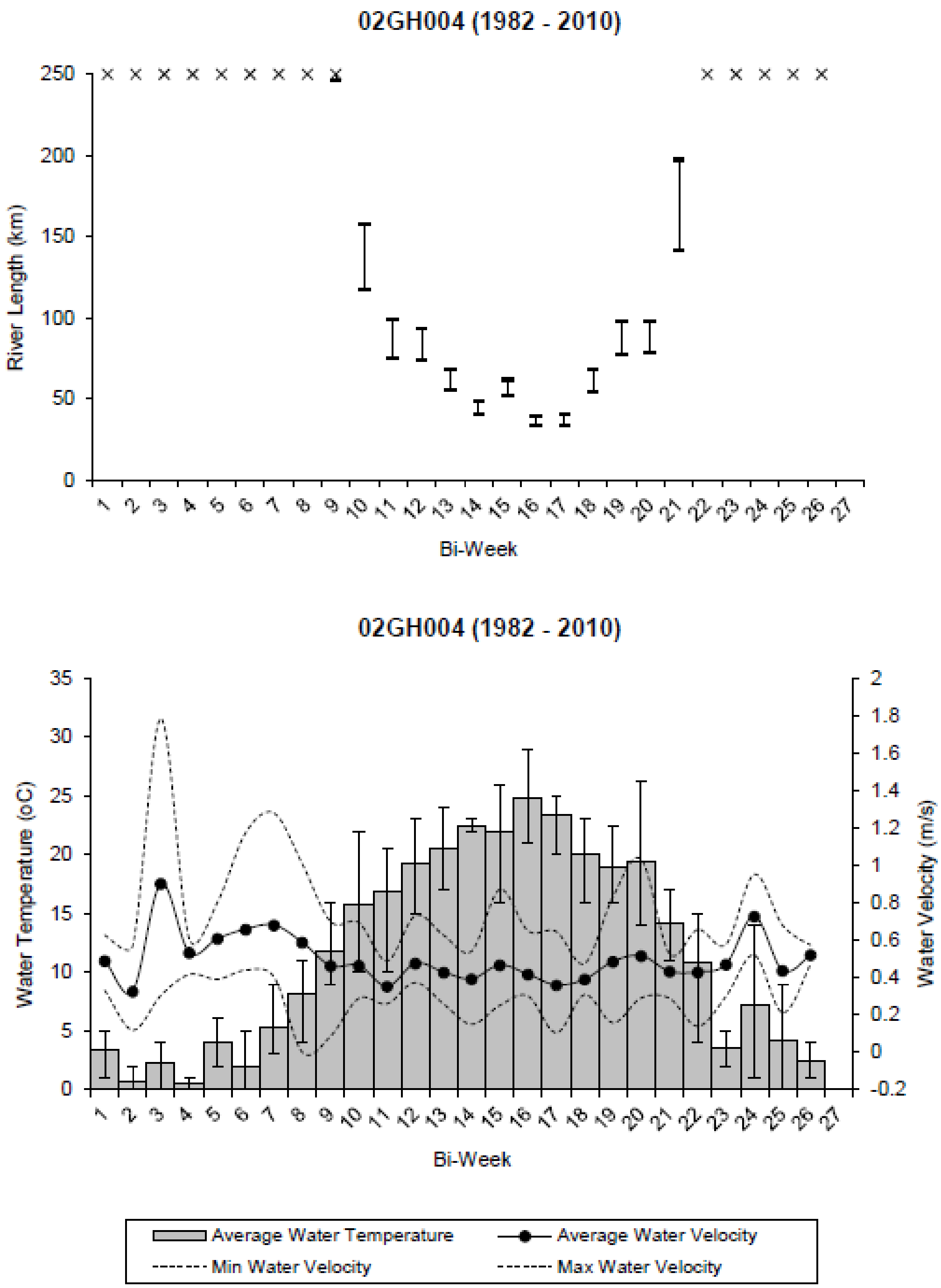


Figure A1-143. Gauging station 02GH004 data from 1982–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

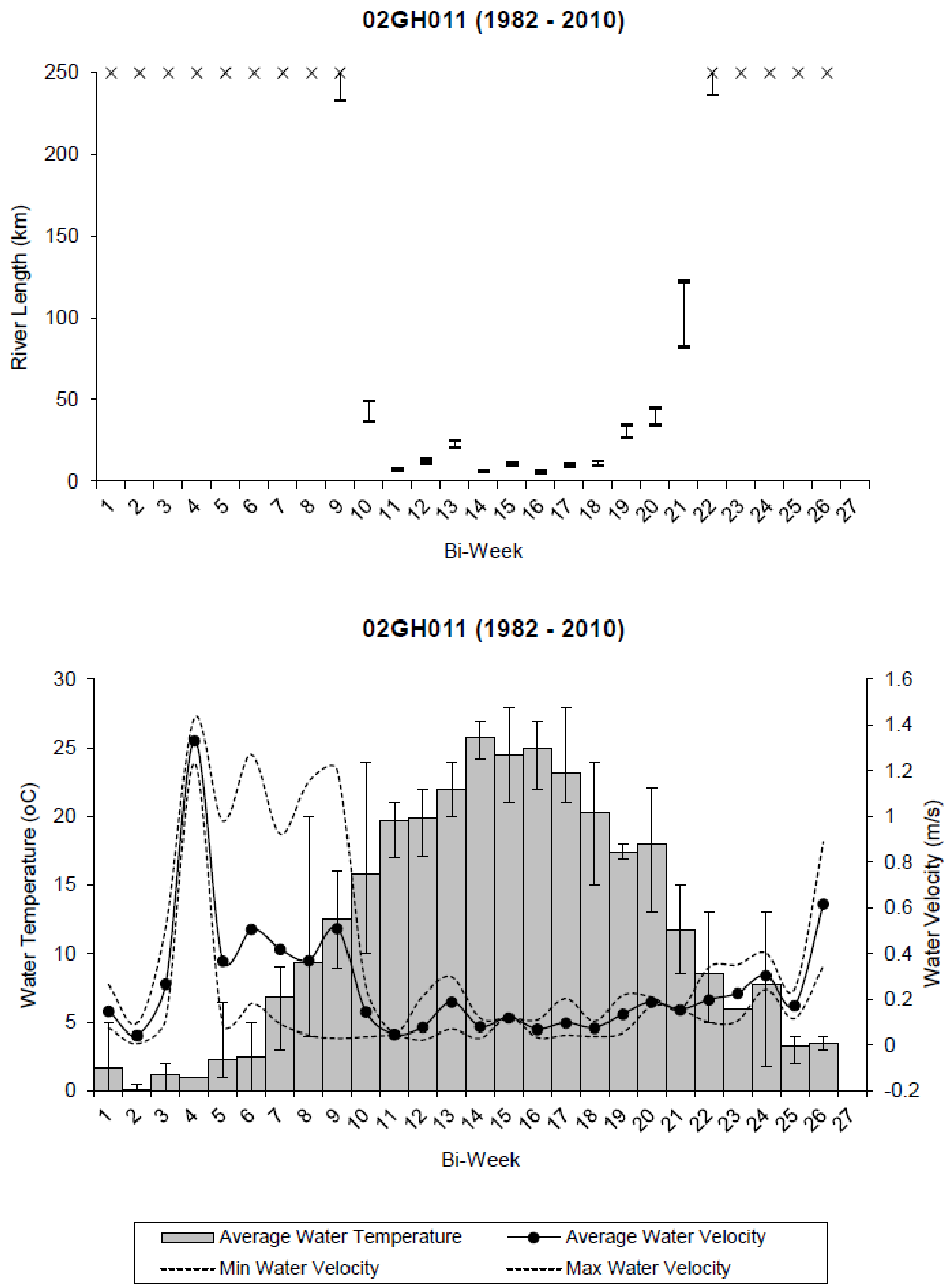
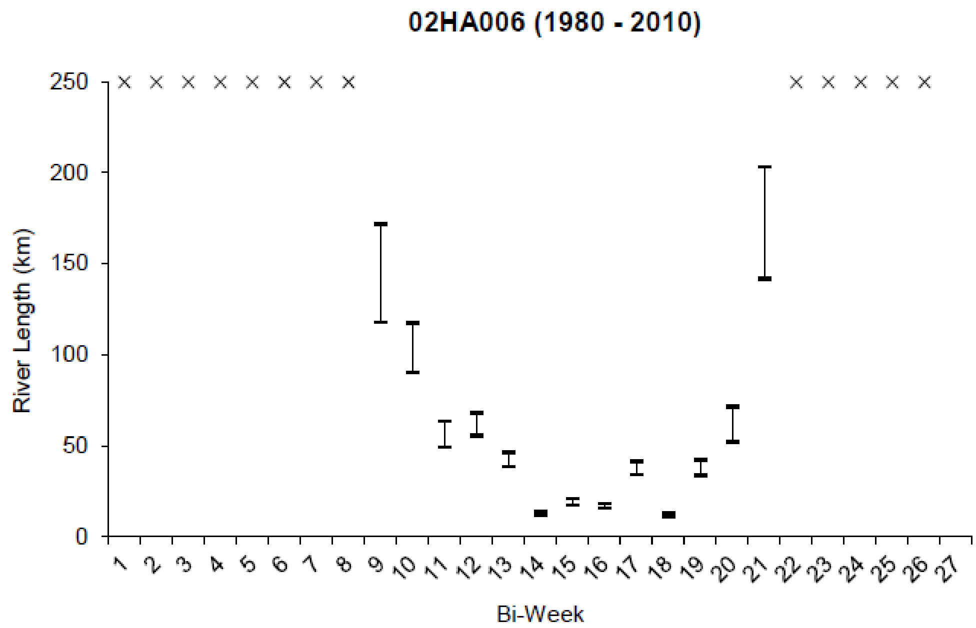


Figure A1-144. Gauging station 02GH011 data from 1982–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



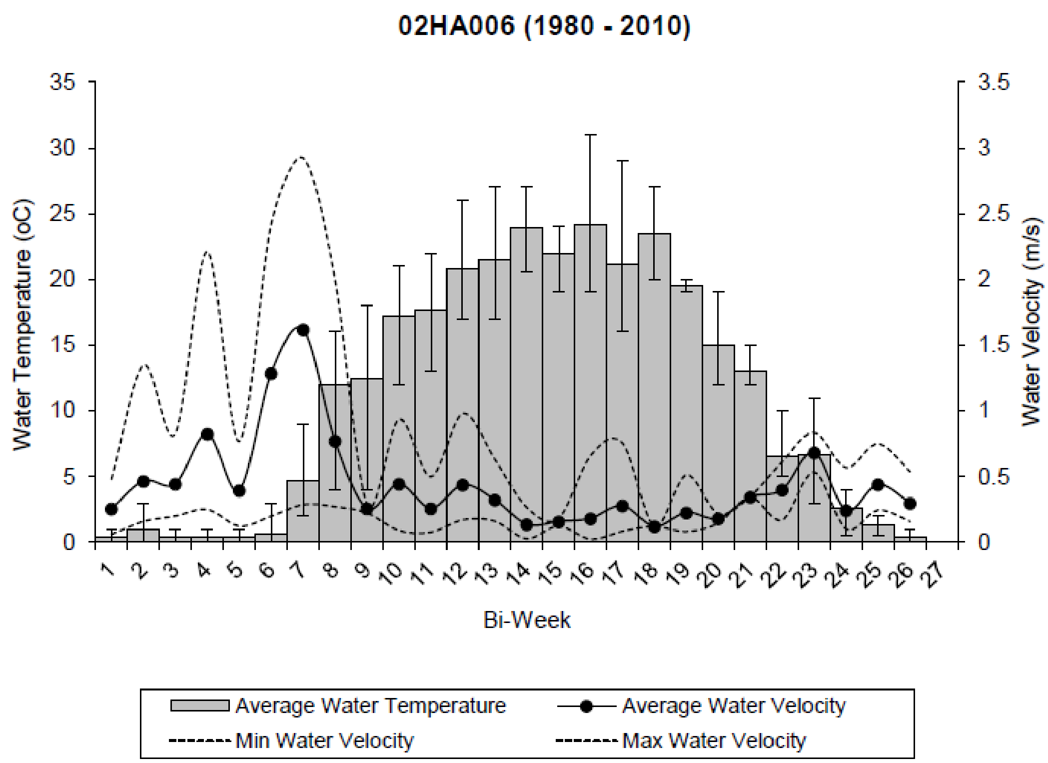
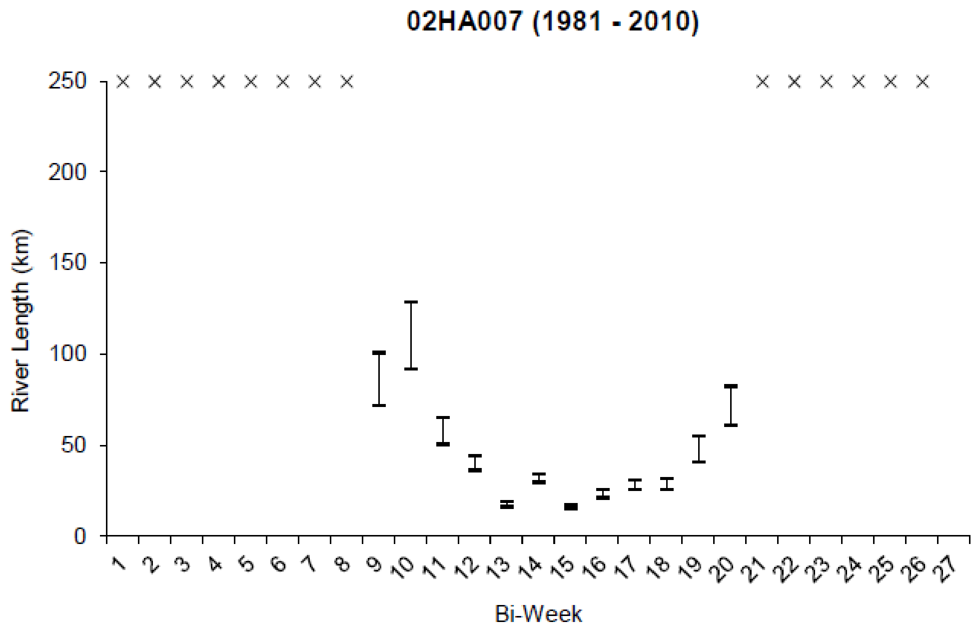


Figure A1-145. Gauging station 02HA006 data from 1982–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



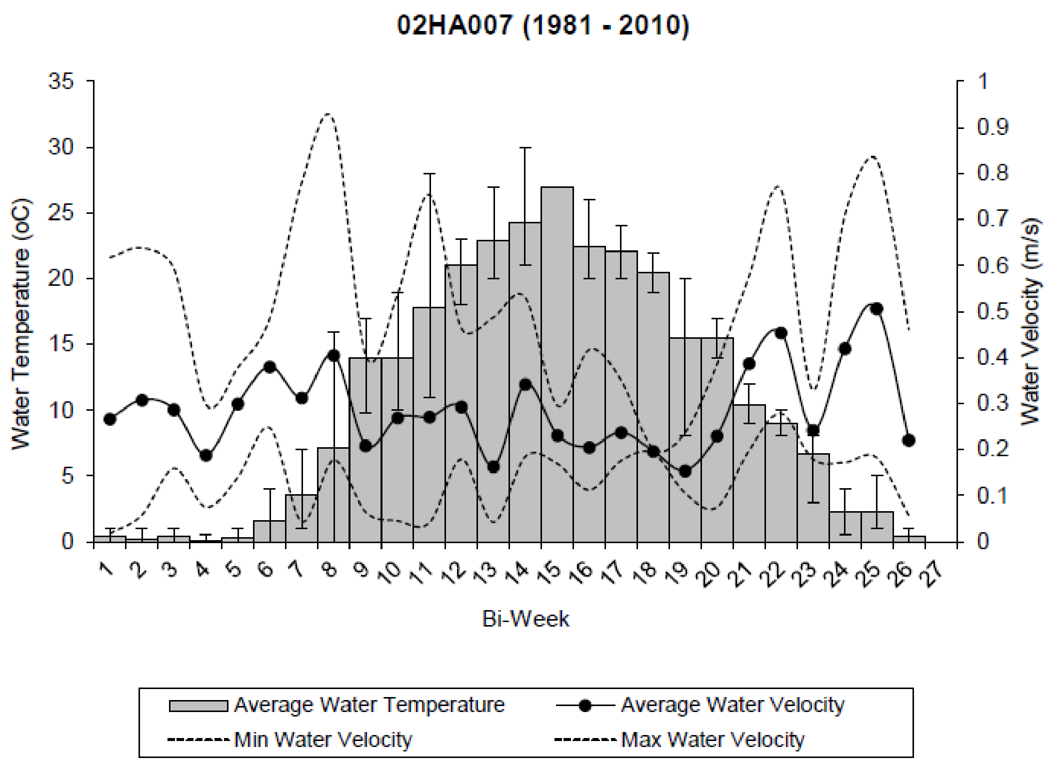
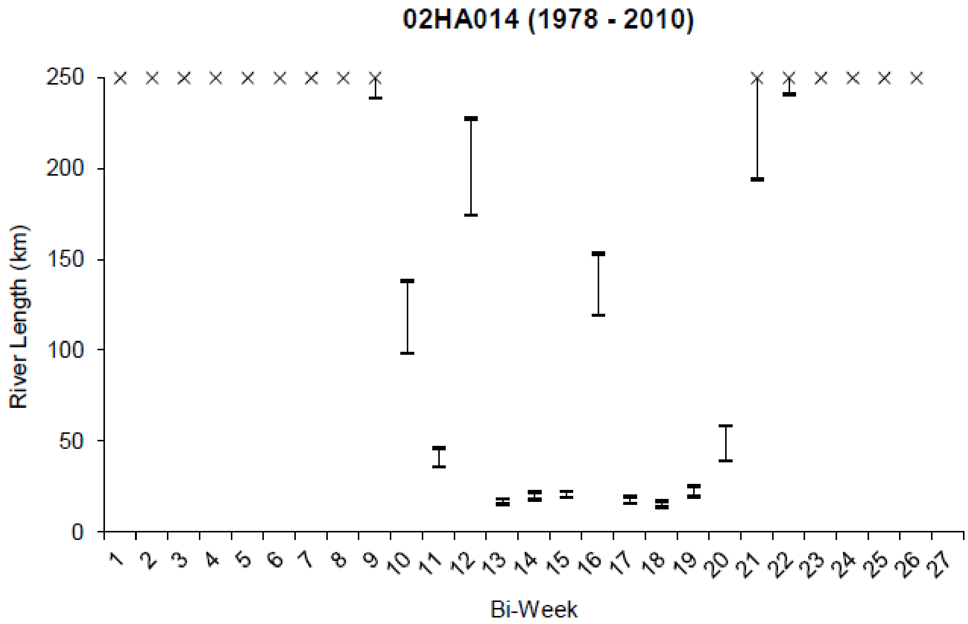


Figure A1-146. Gauging station 02HA007 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



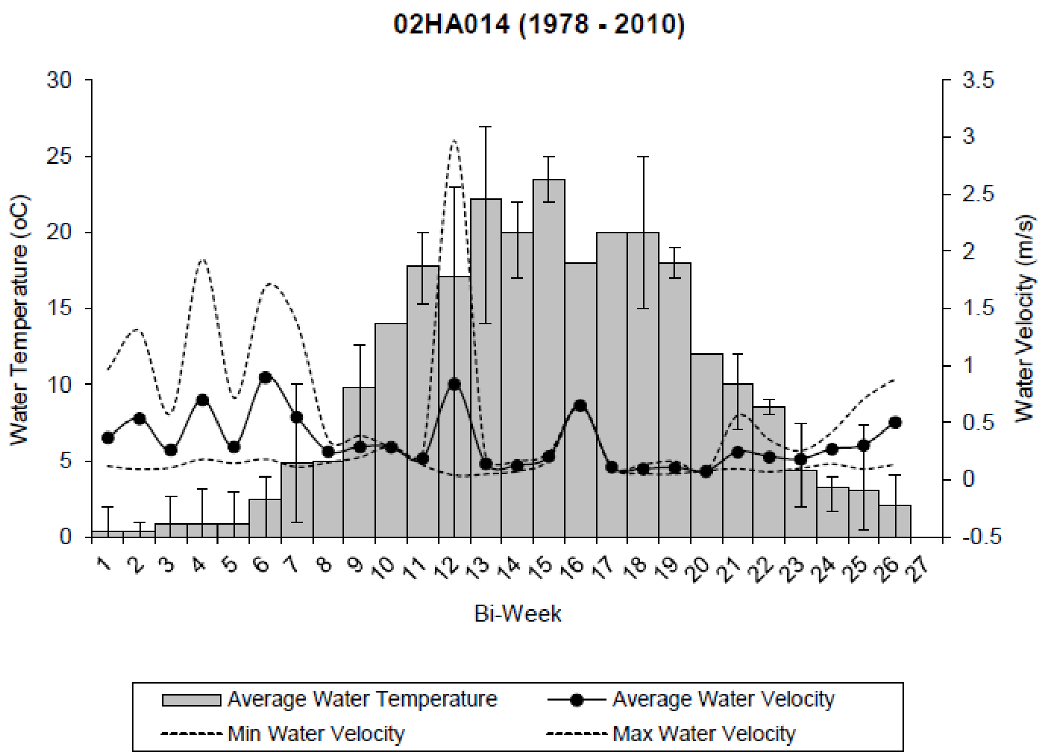
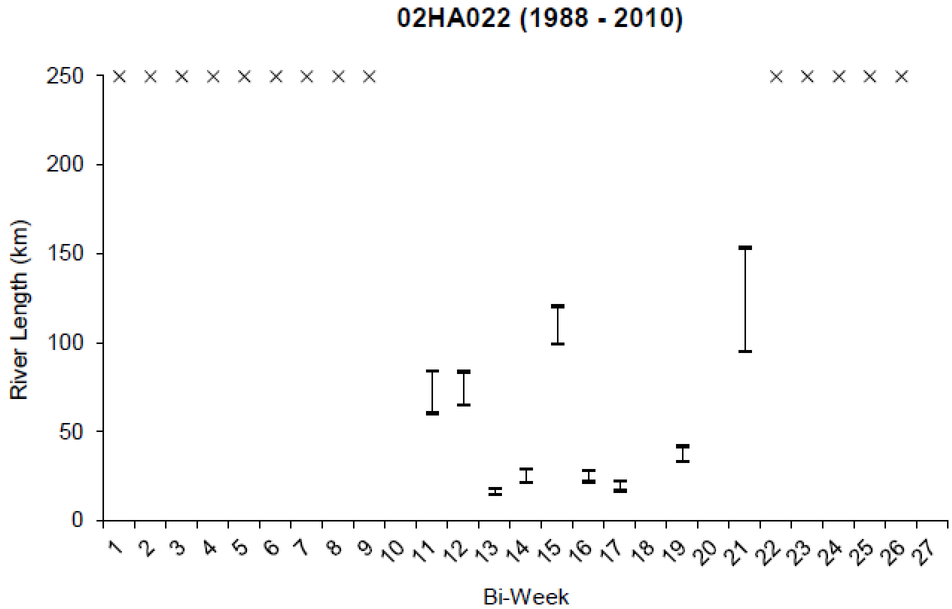


Figure A1-147. Gauging station 02HA014 data from 1978–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



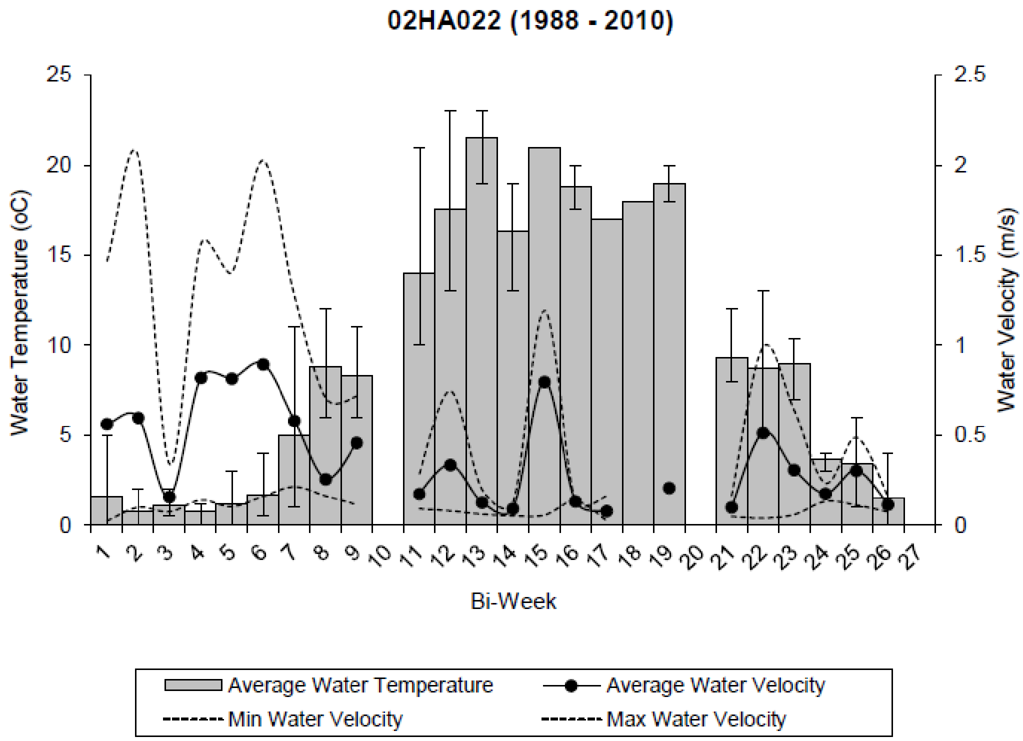
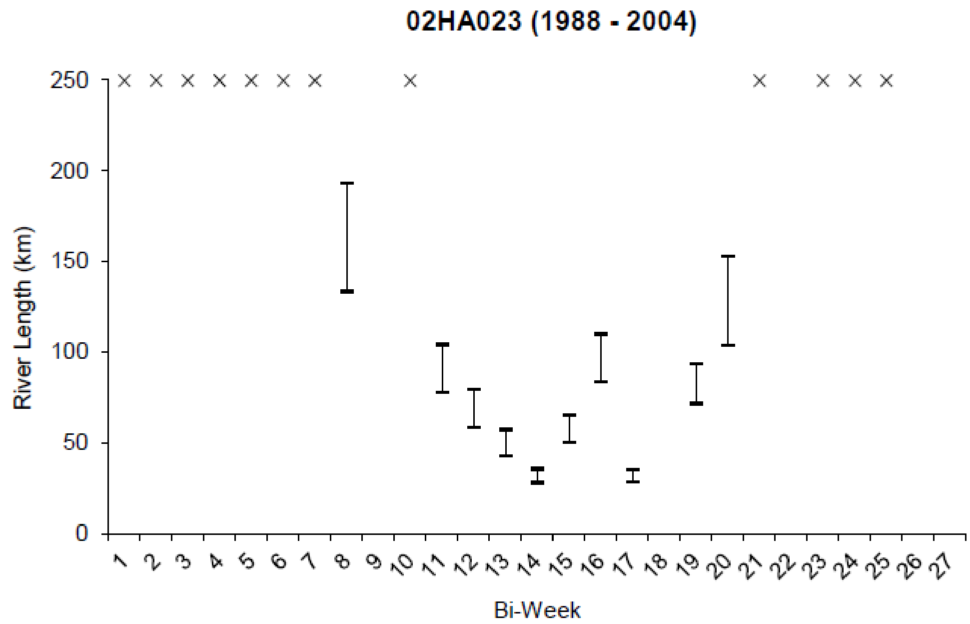


Figure A1-148. Gauging station 02HA022 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



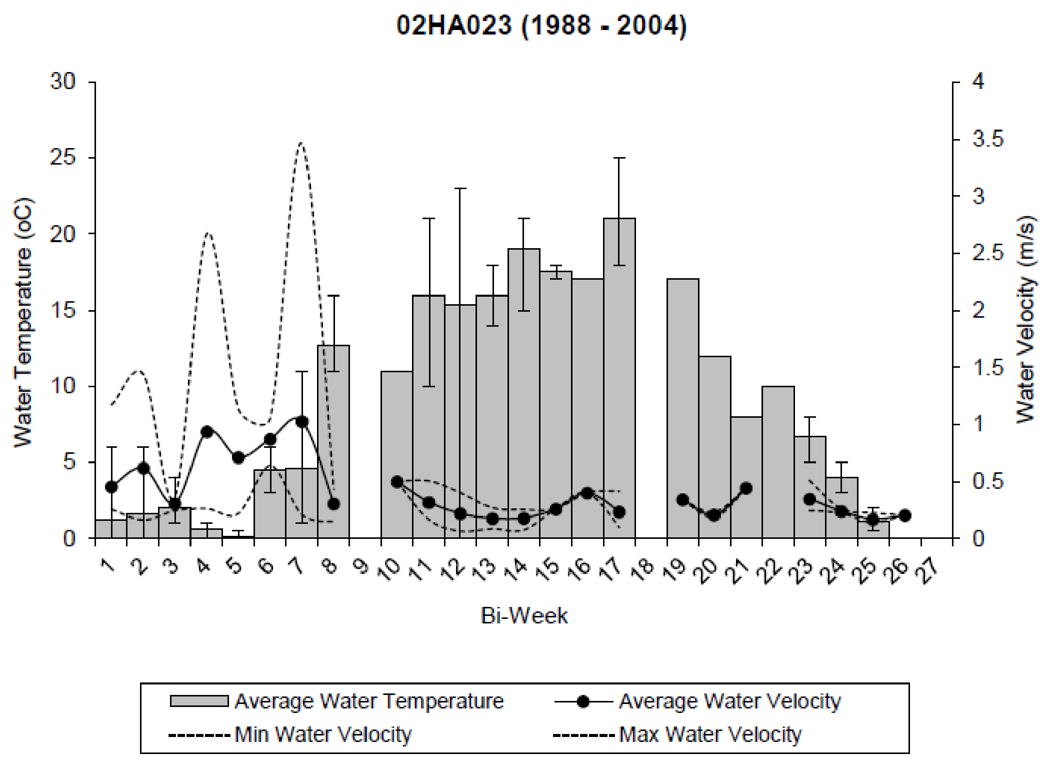
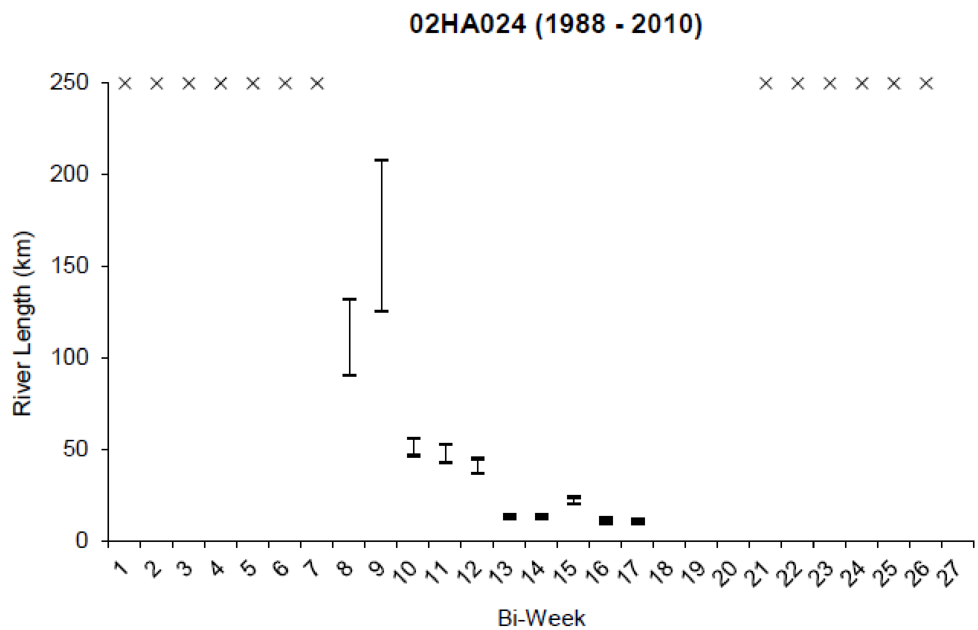


Figure A1-149. Gauging station 02HA023 data from 1988–2004. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



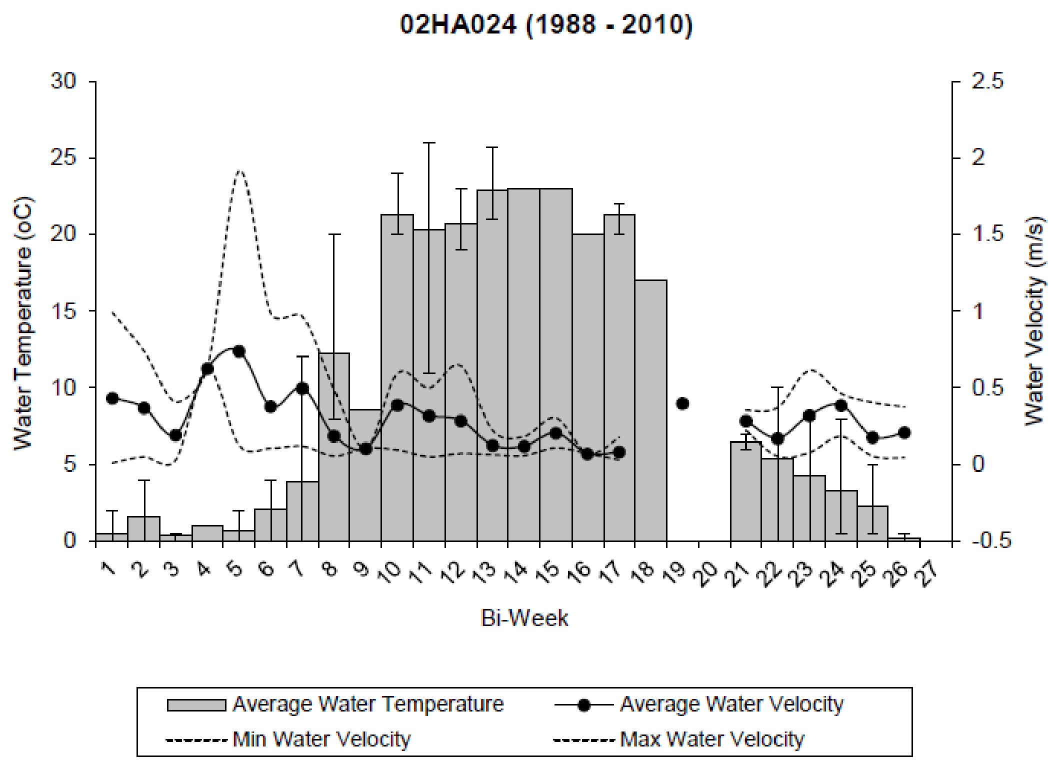
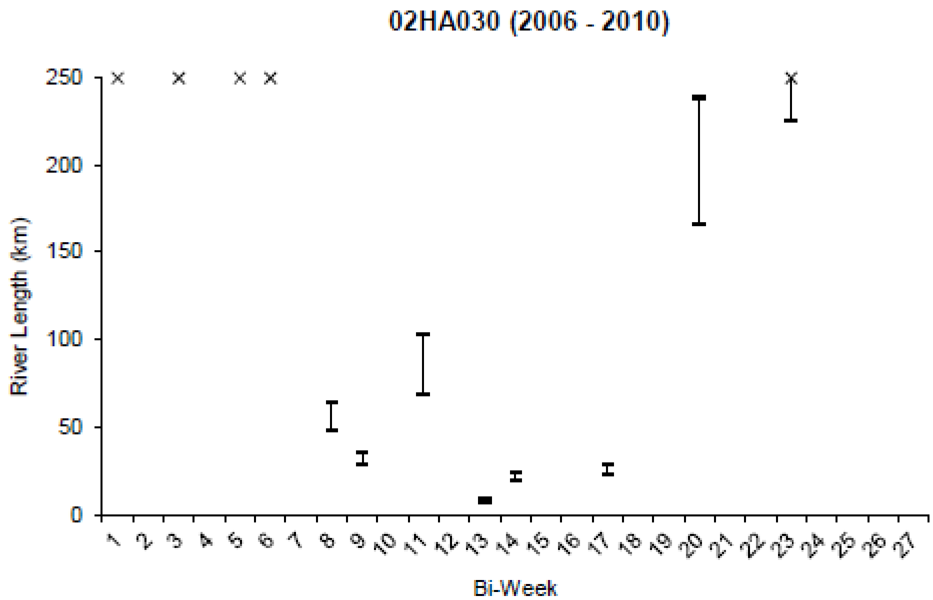


Figure A1-150. Gauging station 02HA024 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



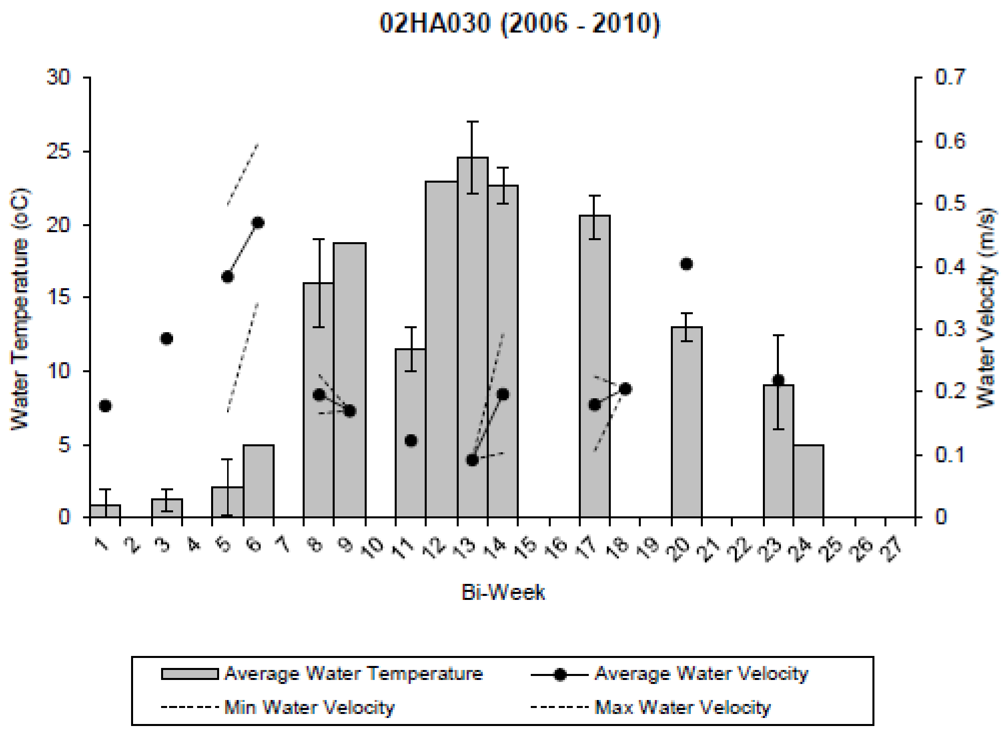


Figure A1-151. Gauging station 02HA030 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

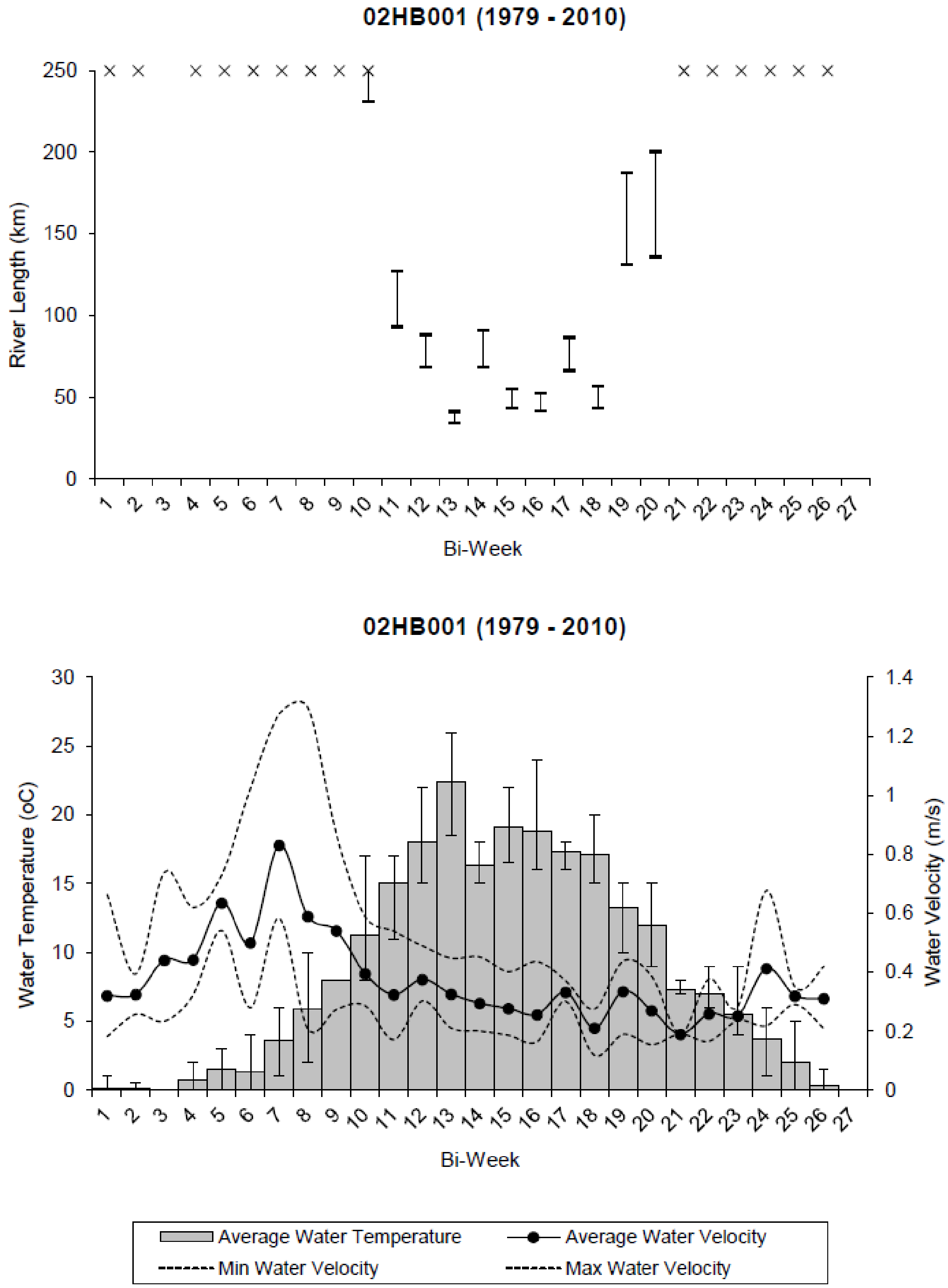
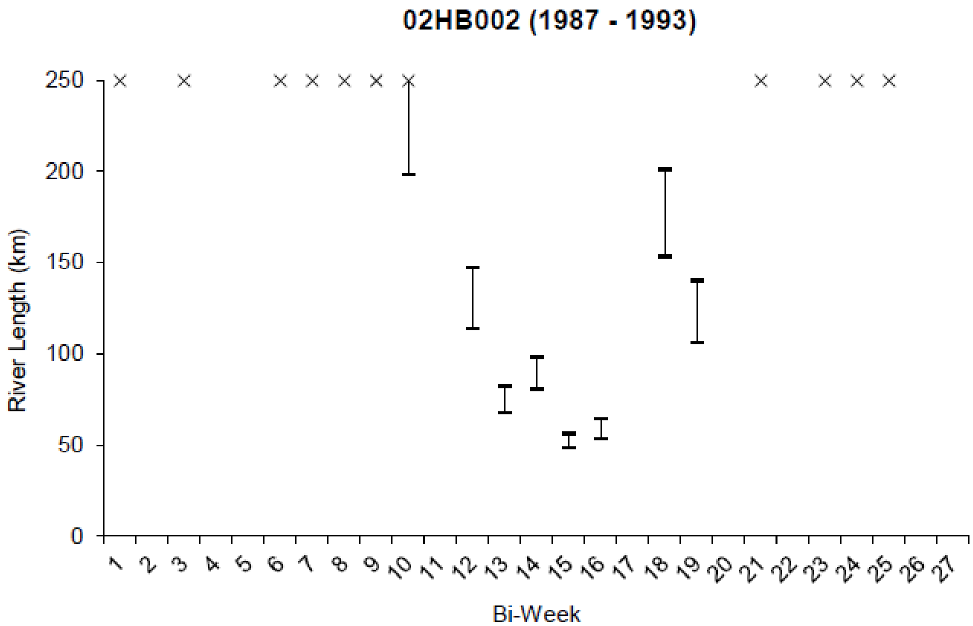


Figure A1-152. Gauging station 02HB001 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



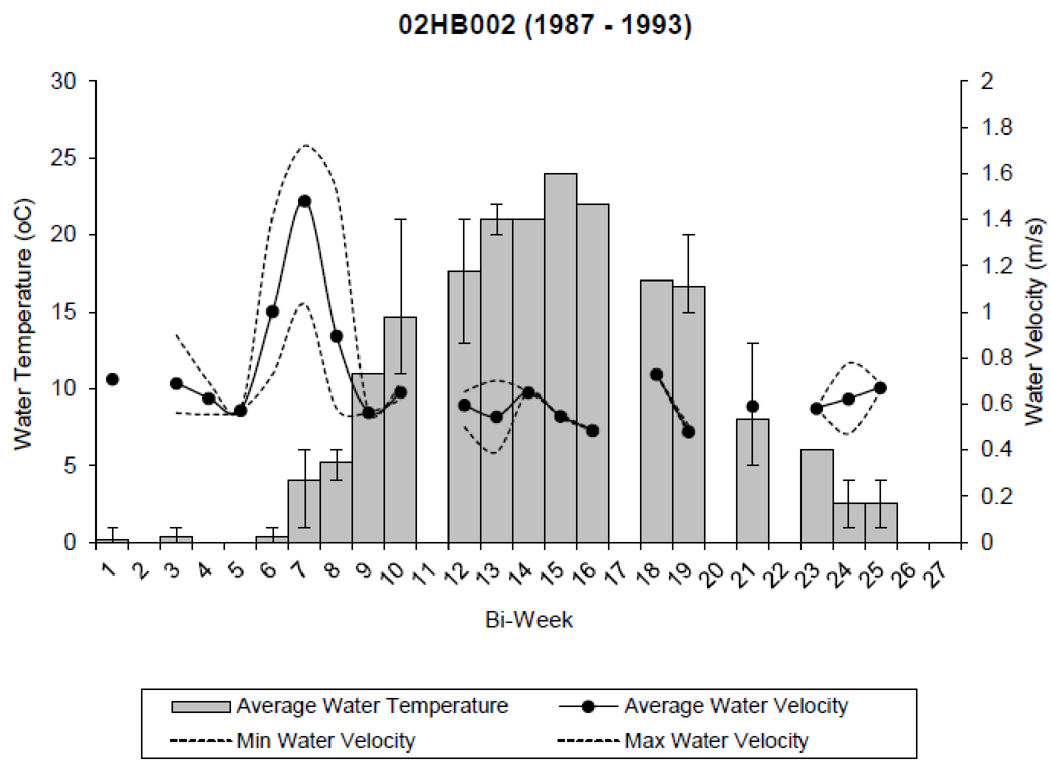
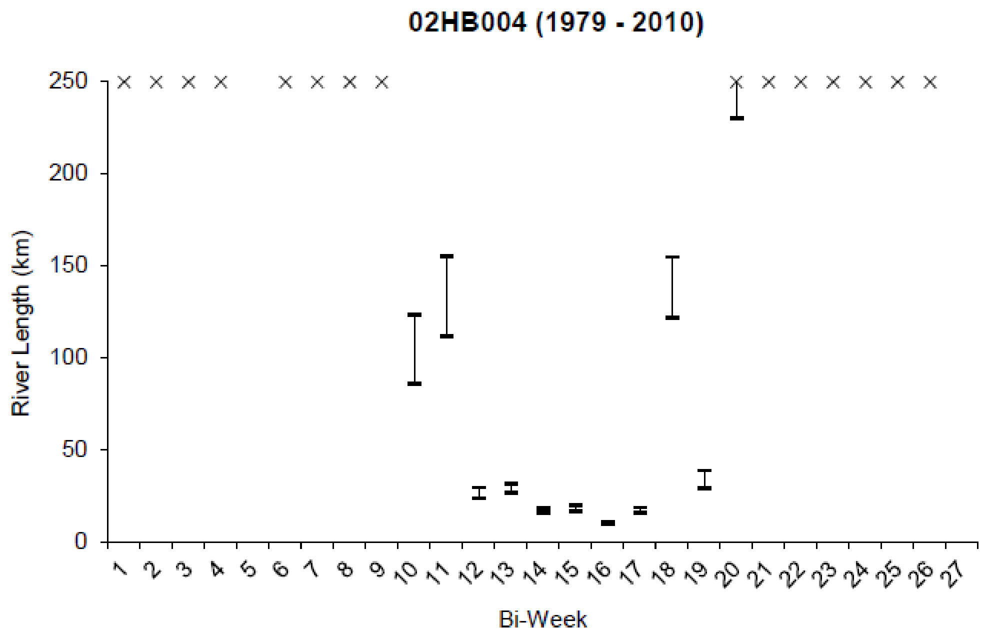


Figure A1-153. Gauging station 02HB002 data from 1987–1993. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



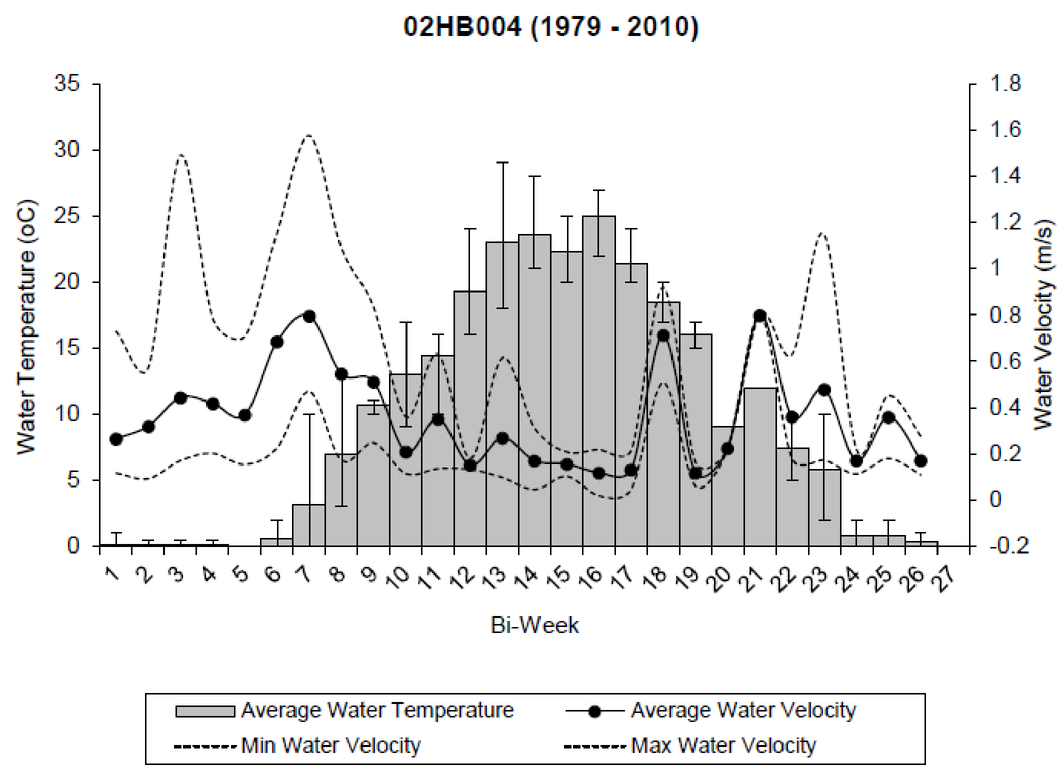
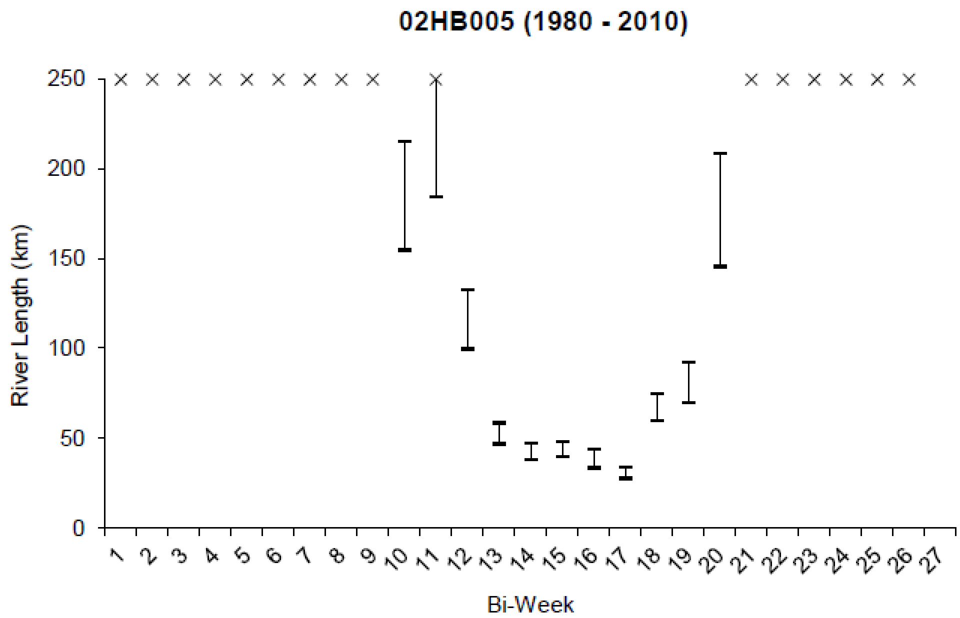


Figure A1-154. Gauging station 02HB004 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



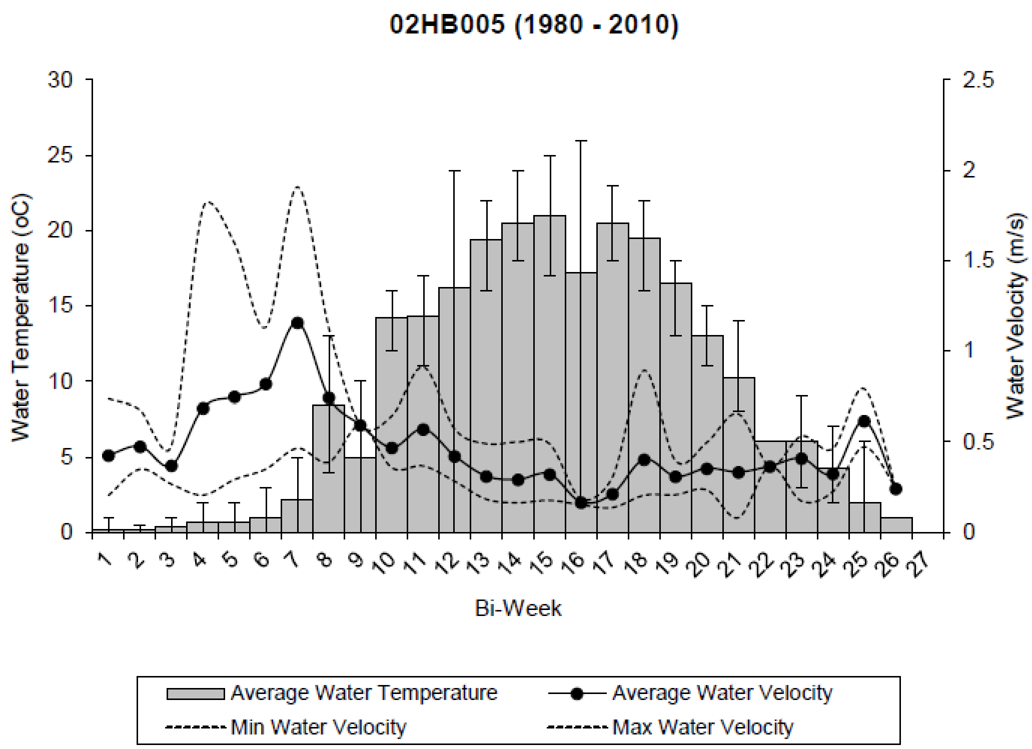
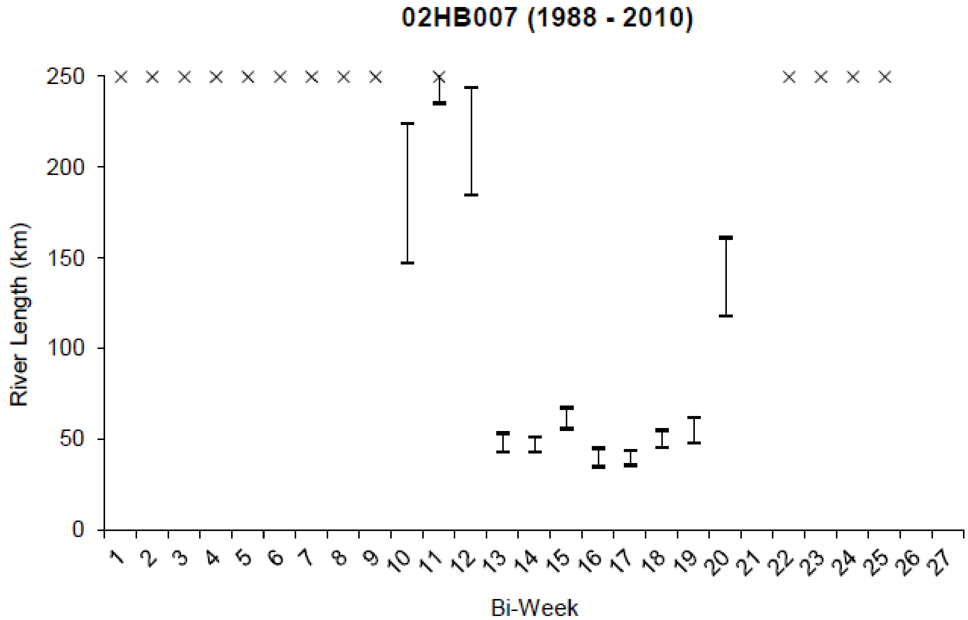


Figure A1-155. Gauging station 02HB005 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



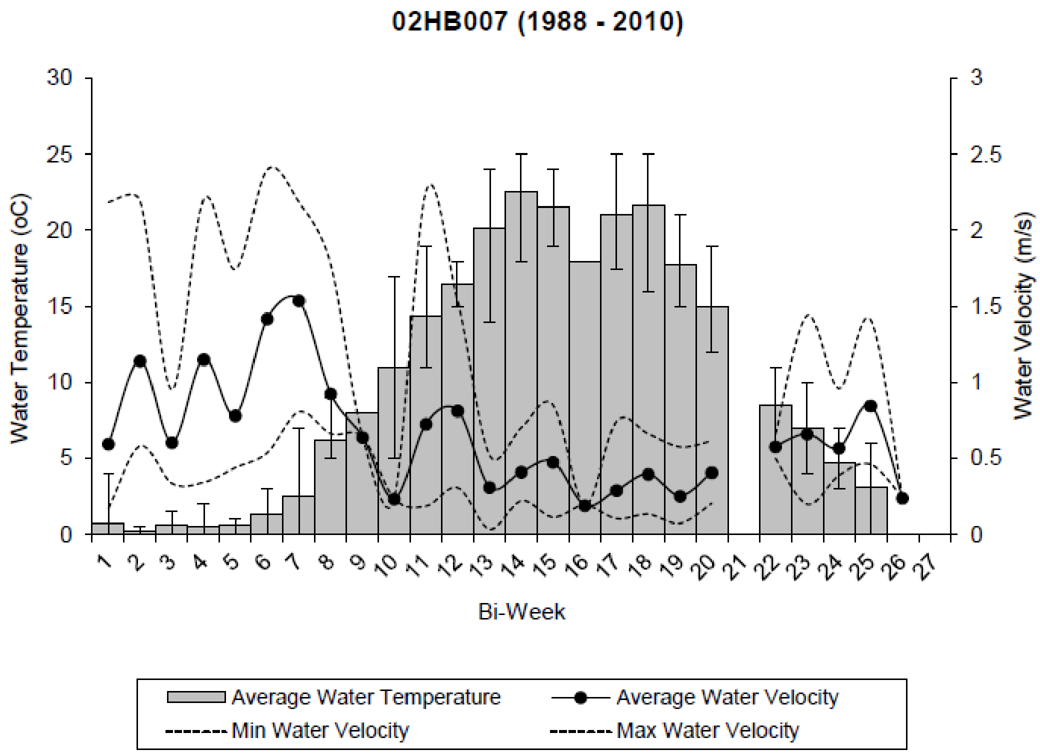
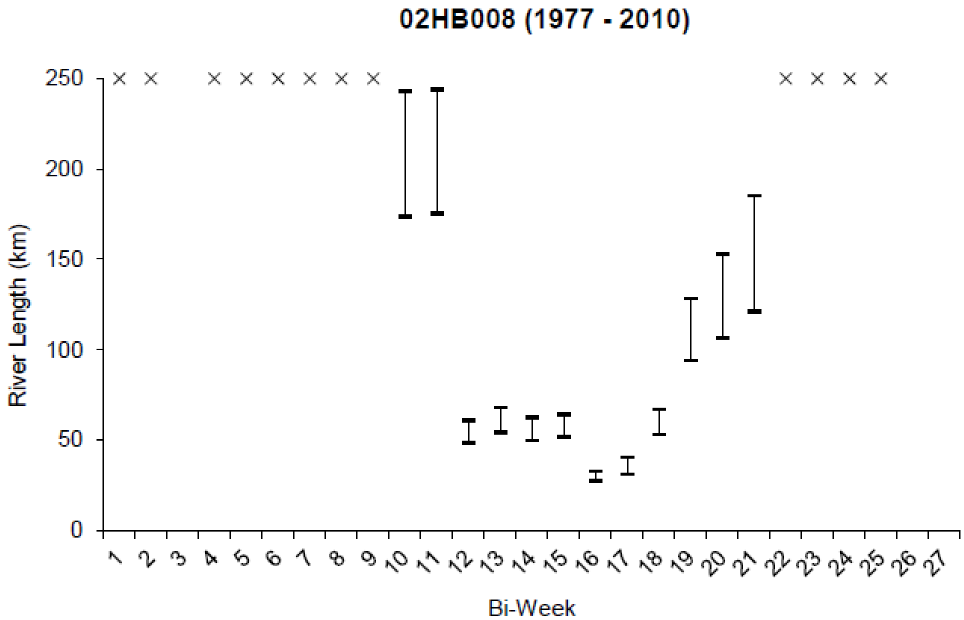


Figure A1-156. Gauging station 02HB006 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



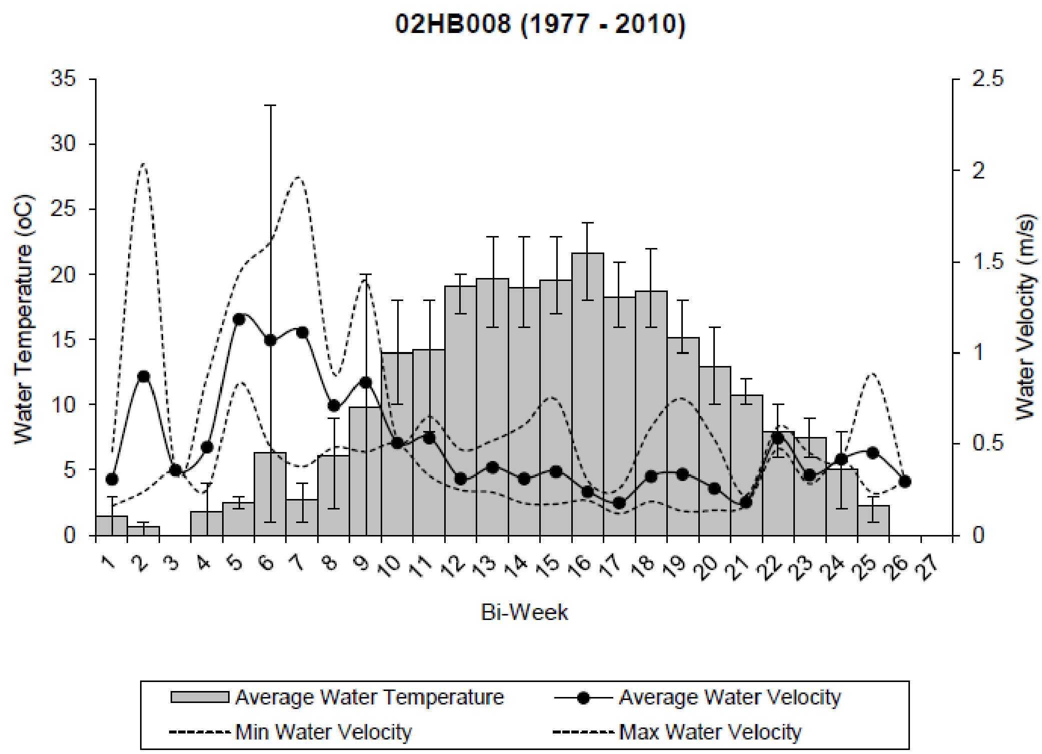
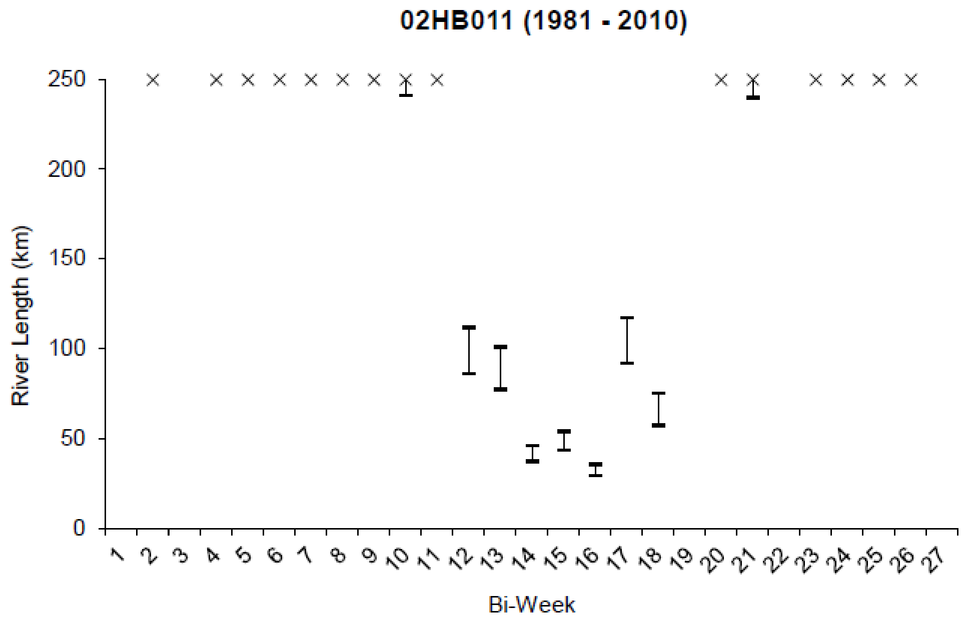


Figure A1-157. Gauging station 02HB008 data from 1977–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



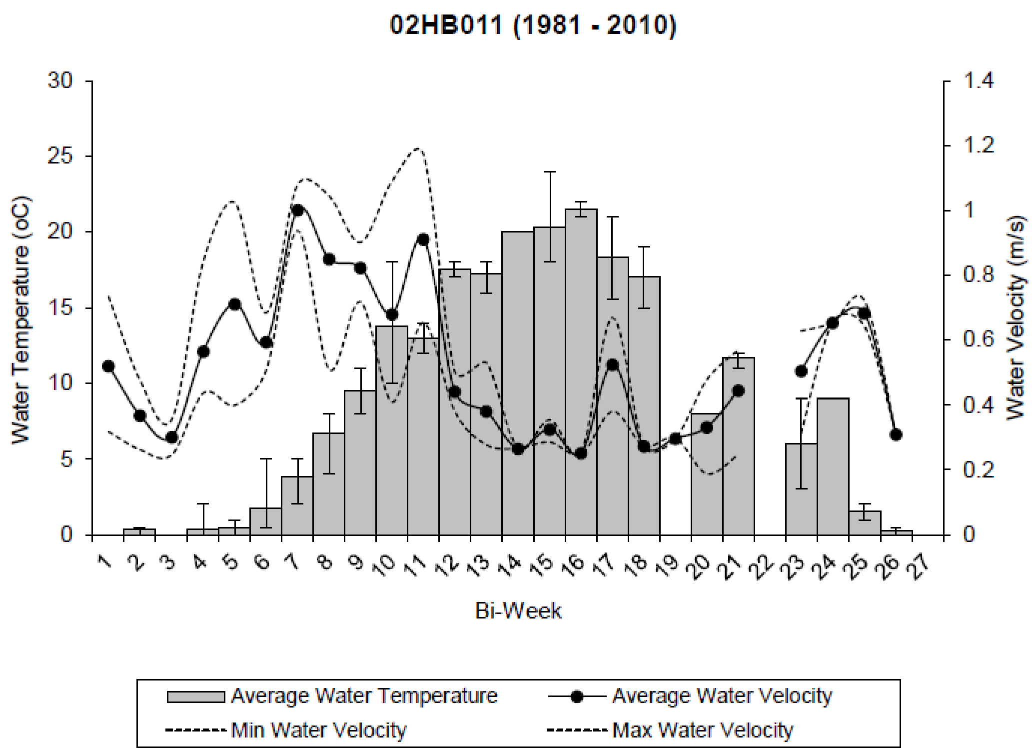
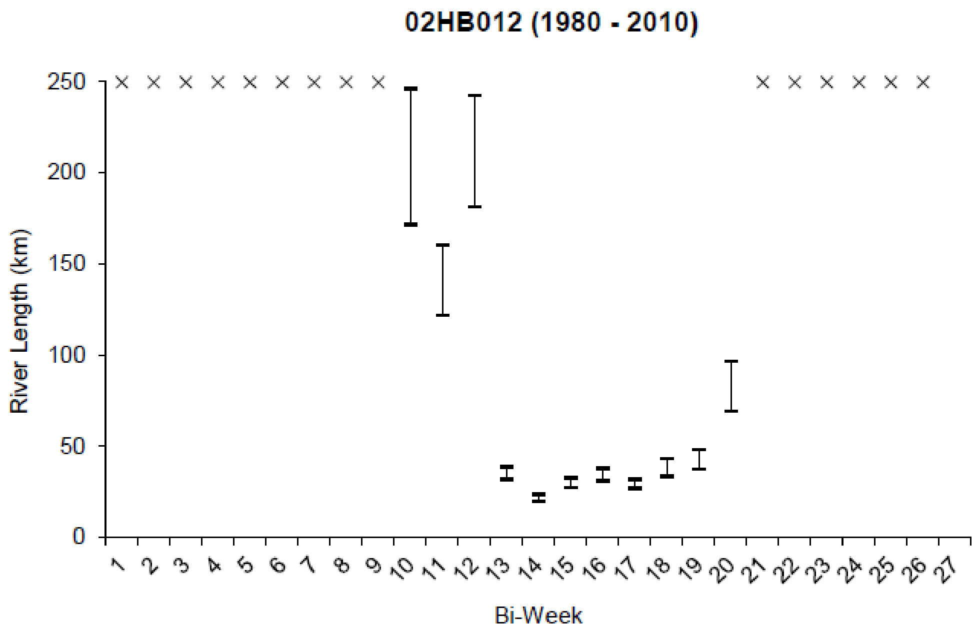


Figure A1-158. Gauging station 02HB011 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



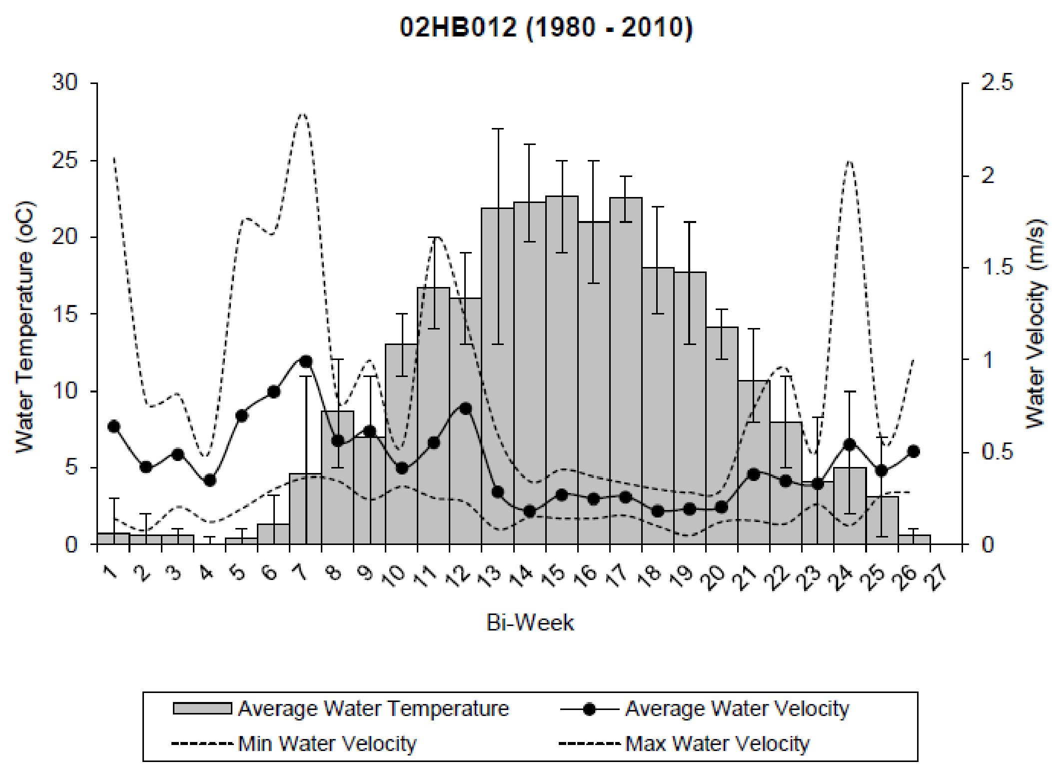
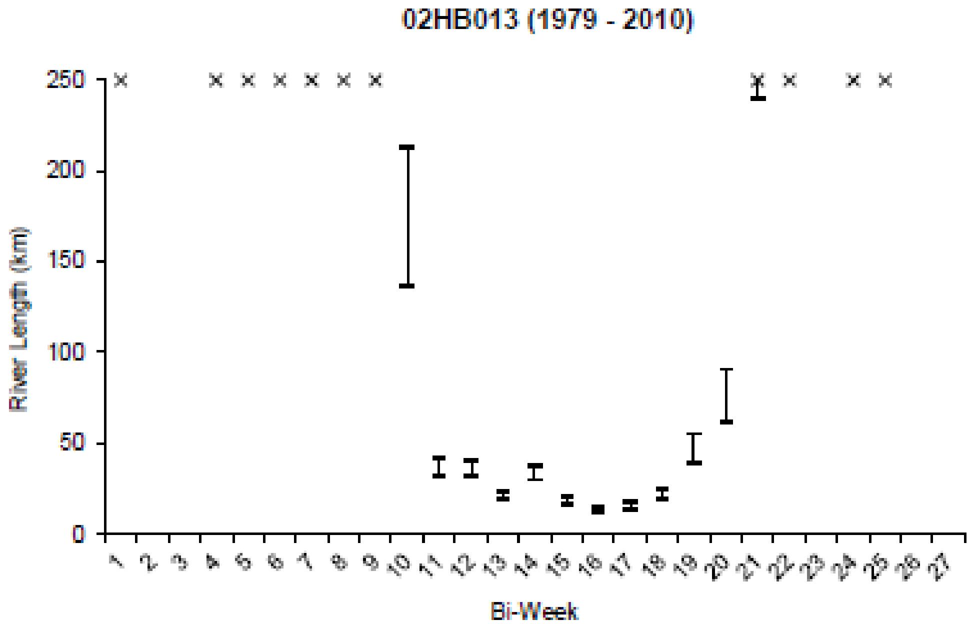


Figure A1-159. Gauging station 02HB012 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



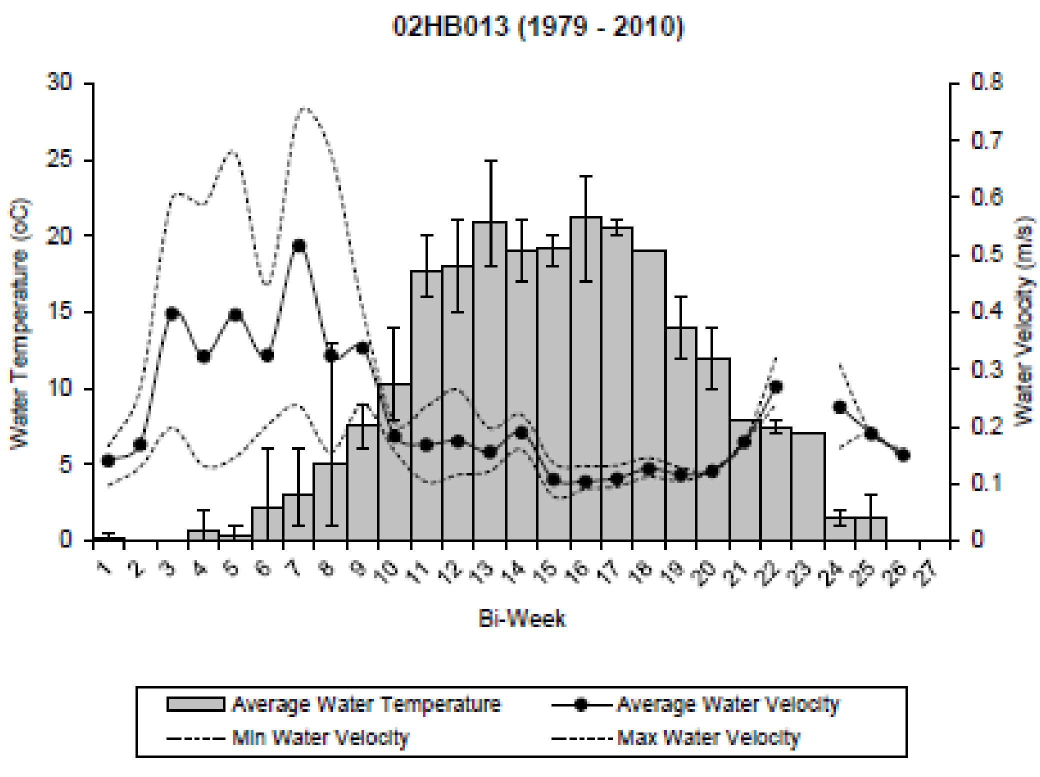
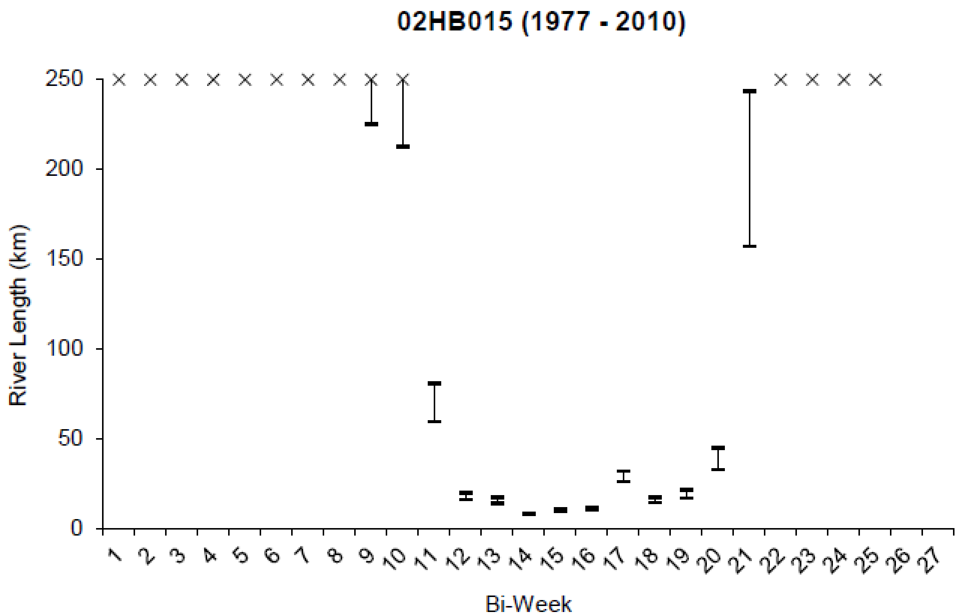


Figure A1-160. Gauging station 02HB013 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



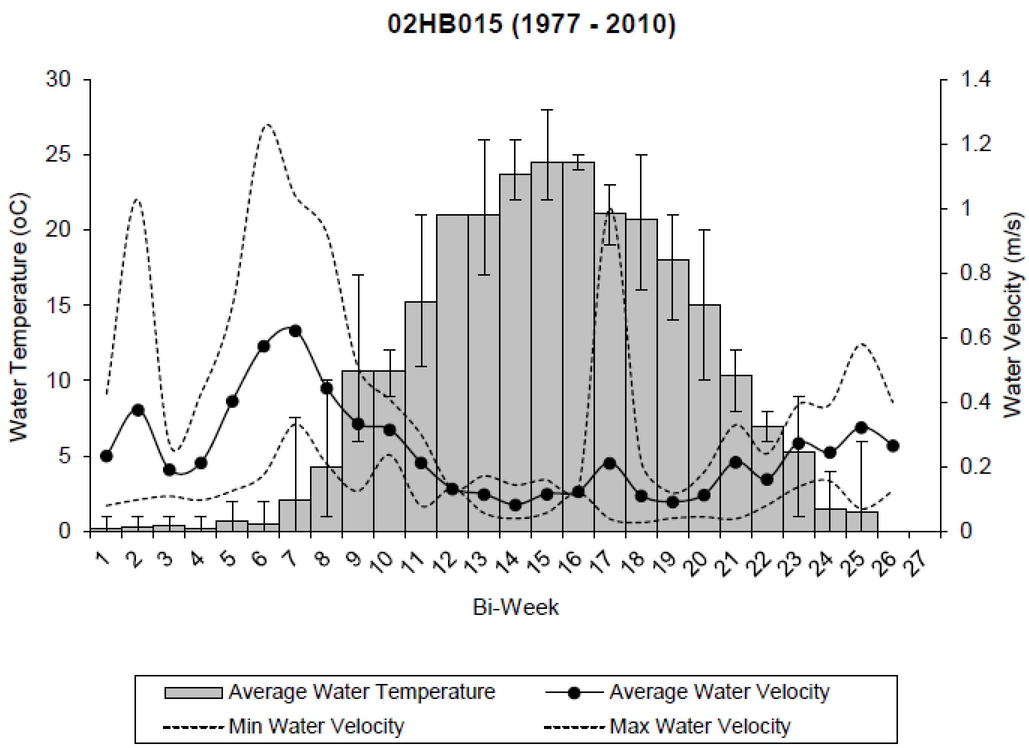


Figure A1-161. Gauging station 02HB015 data from 1977–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

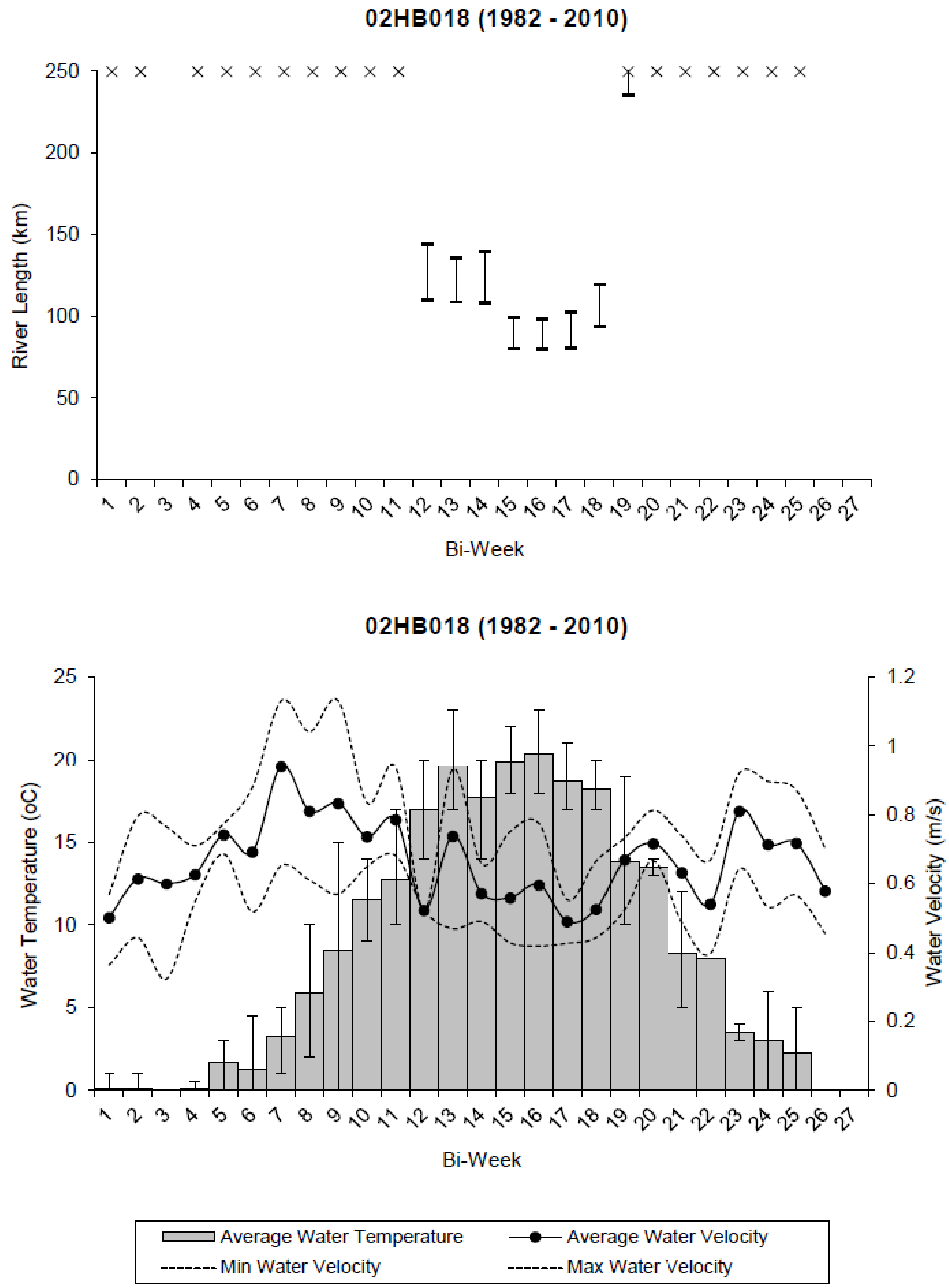
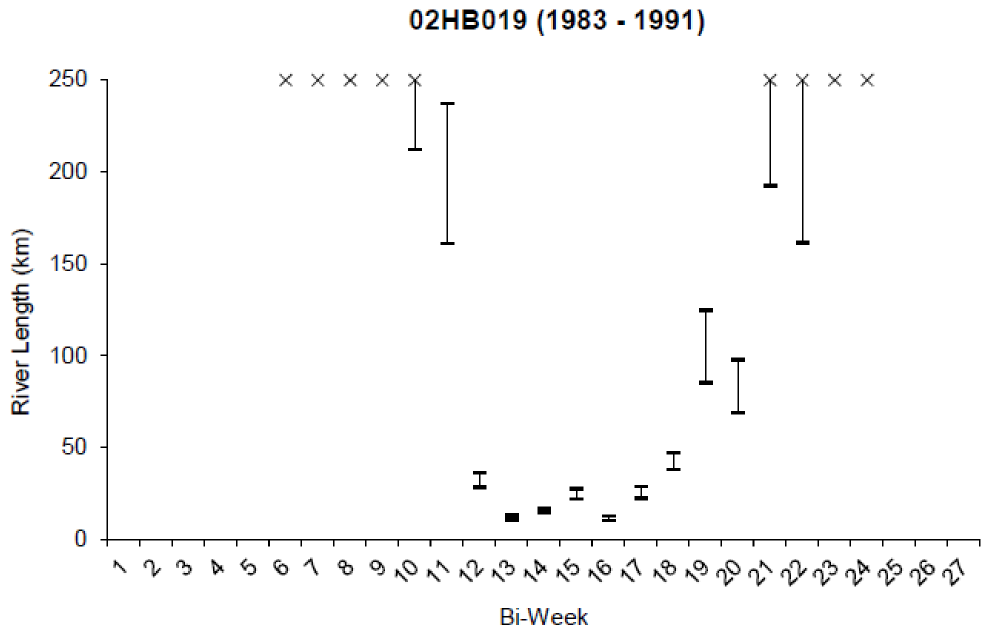


Figure A1-162. Gauging station 02HB018 data from 1982–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



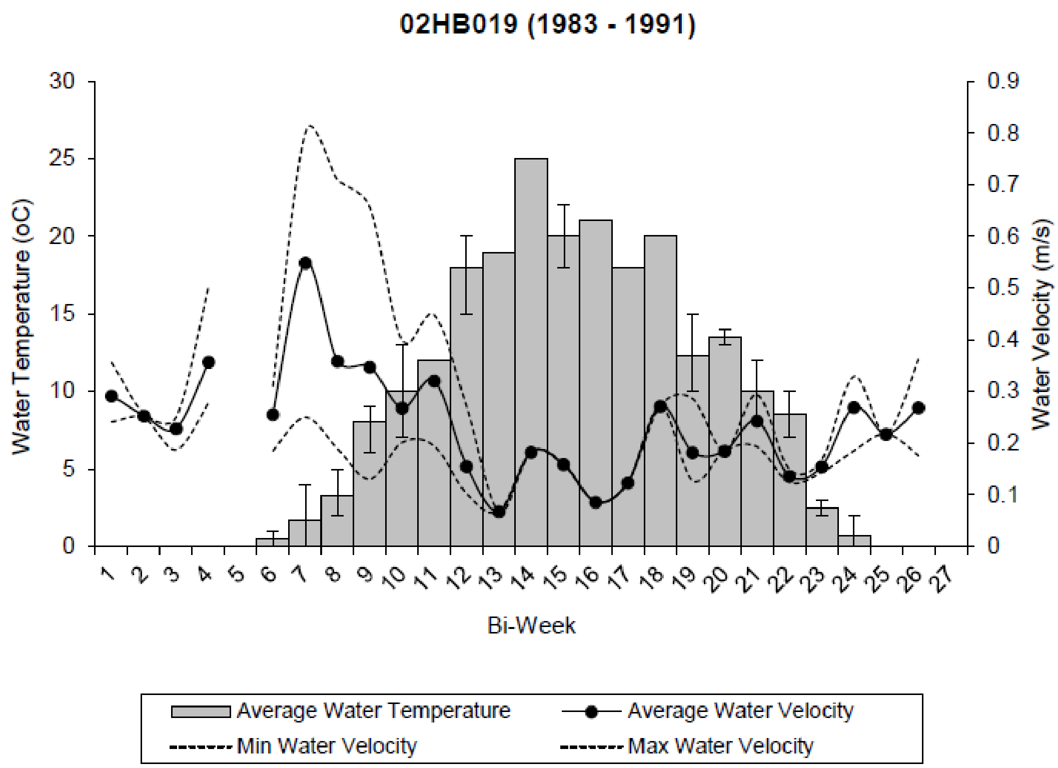
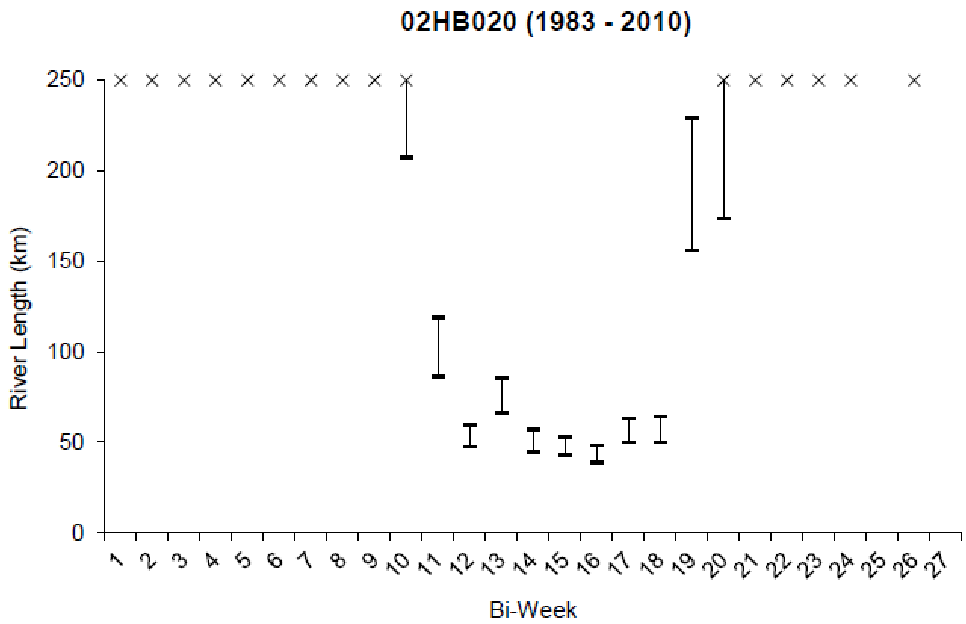


Figure A1-163. Gauging station 02HB019 data from 1983–1991. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



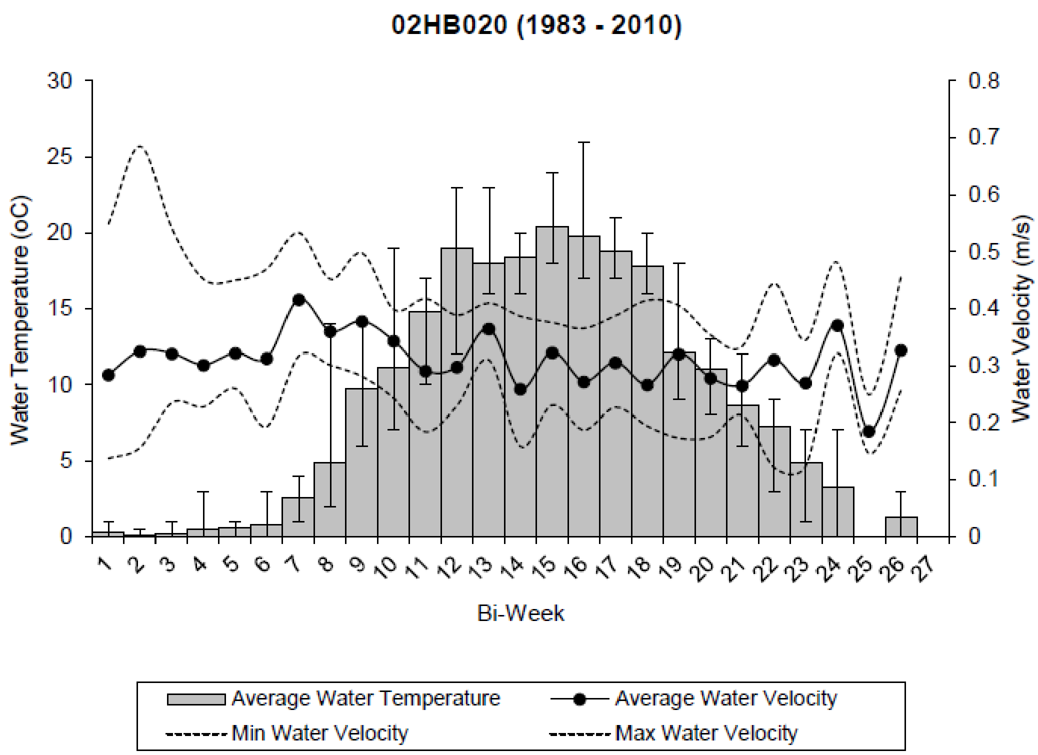
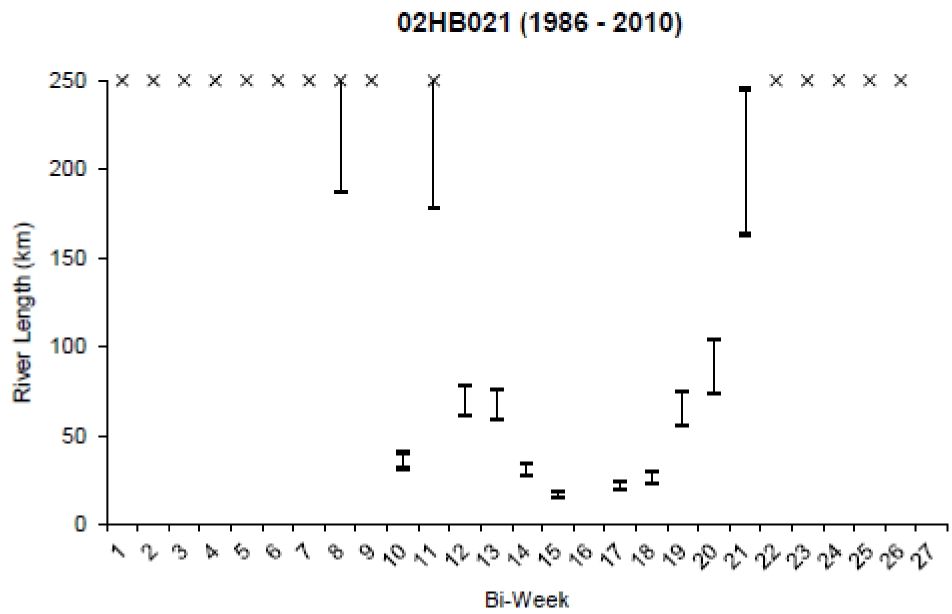


Figure A1-164. Gauging station 02HB020 data from 1983–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



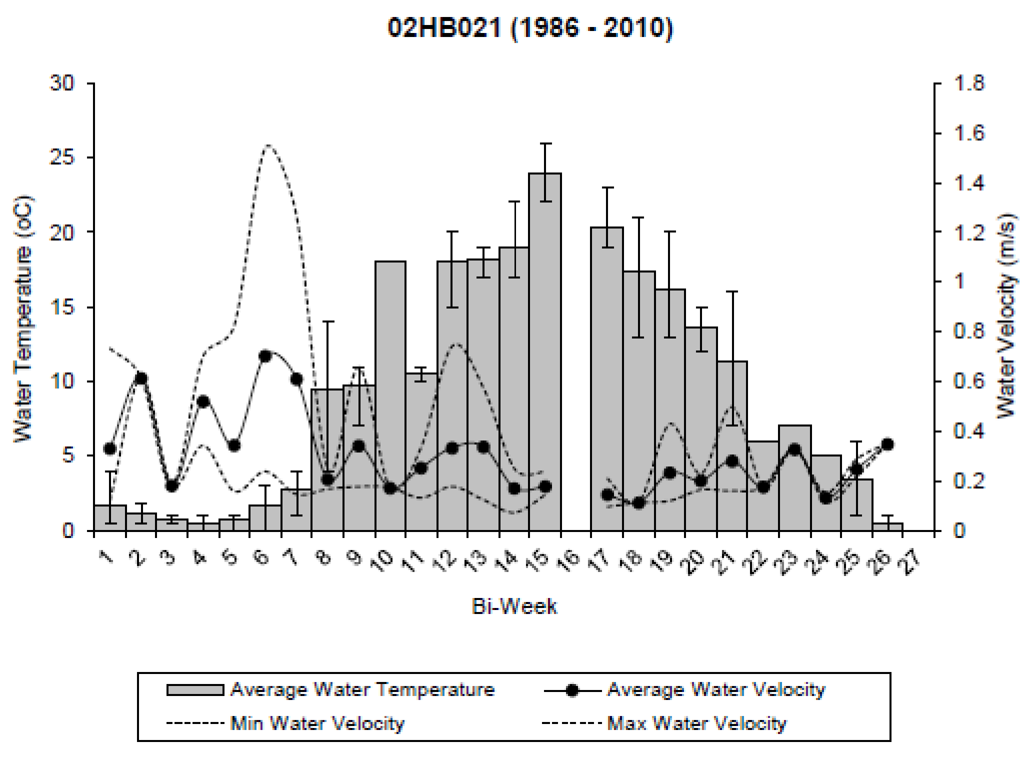
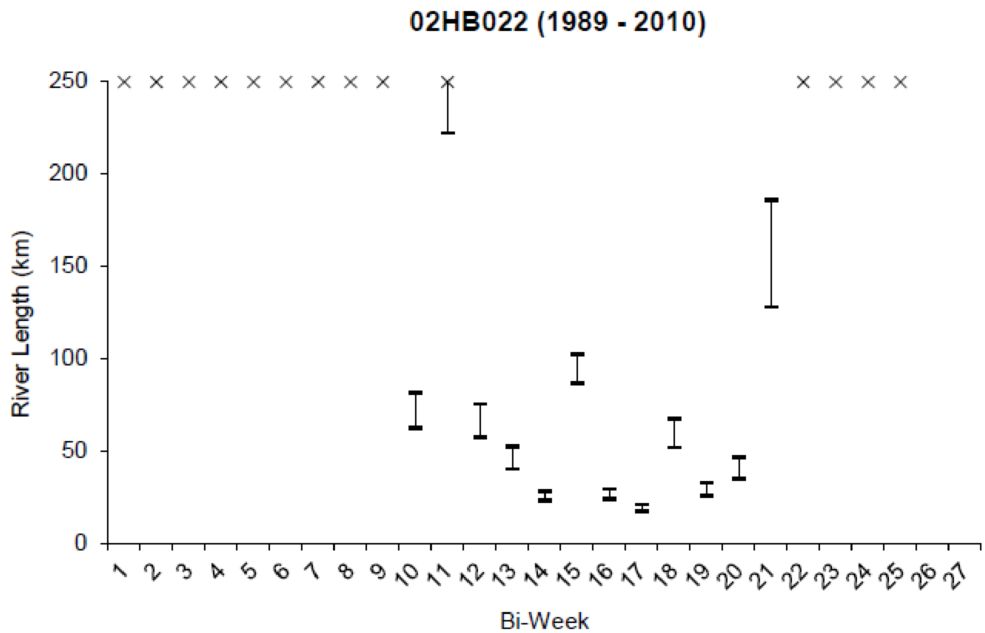


Figure A1-165. Gauging station 02HB021 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



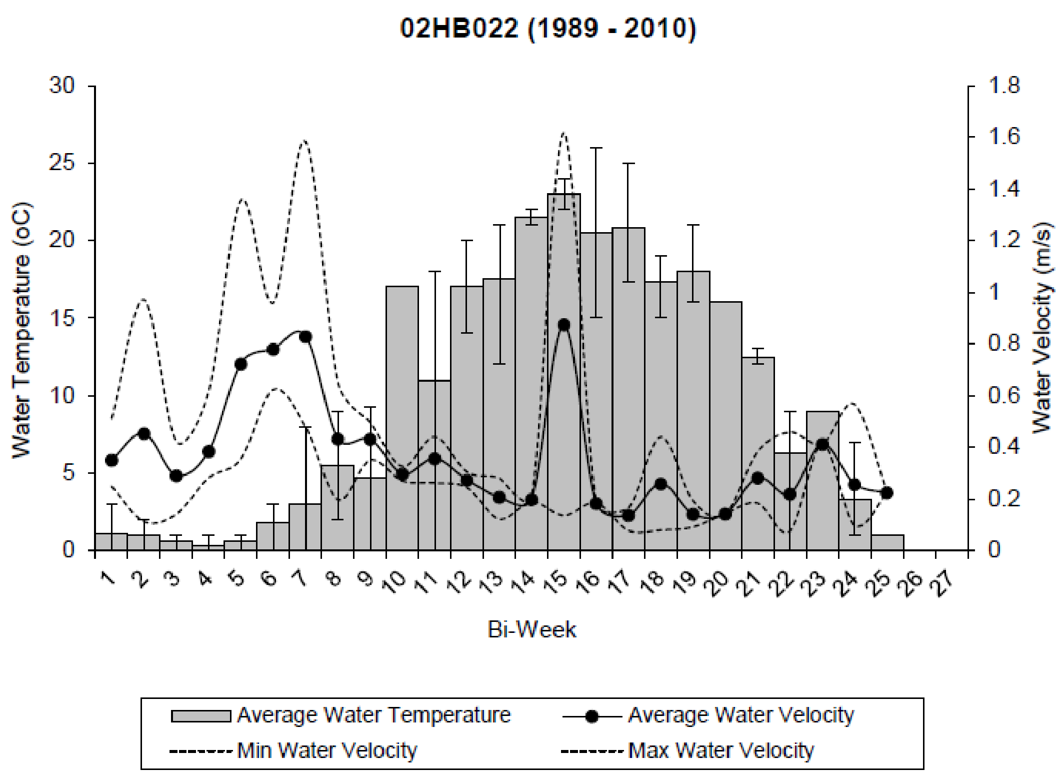
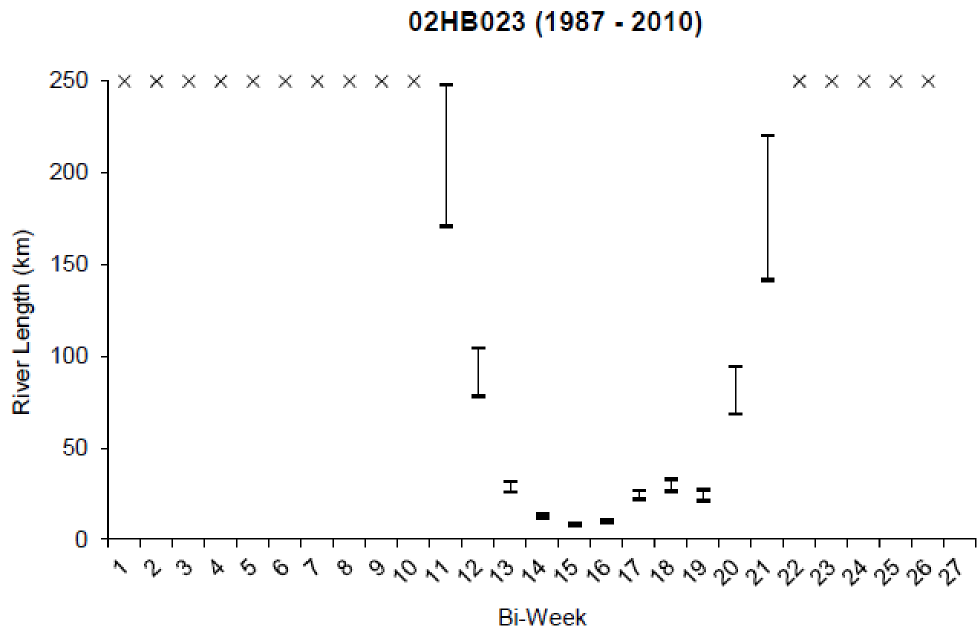


Figure A1-166. Gauging station 02HB022 data from 1989–2001. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



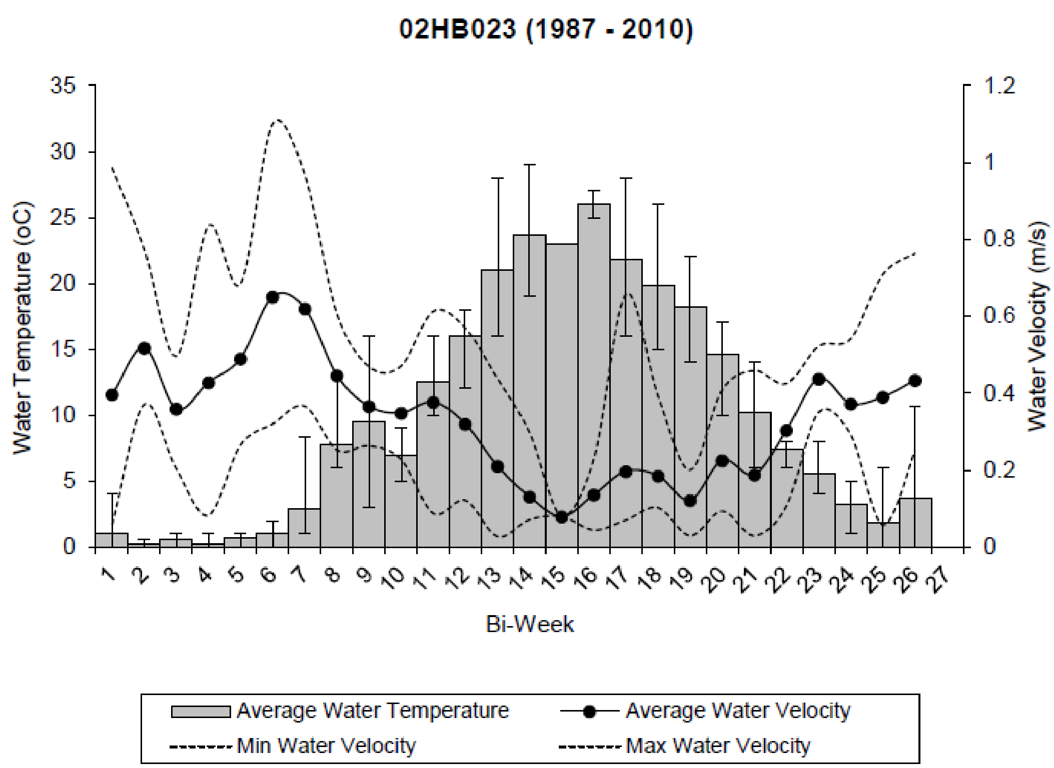
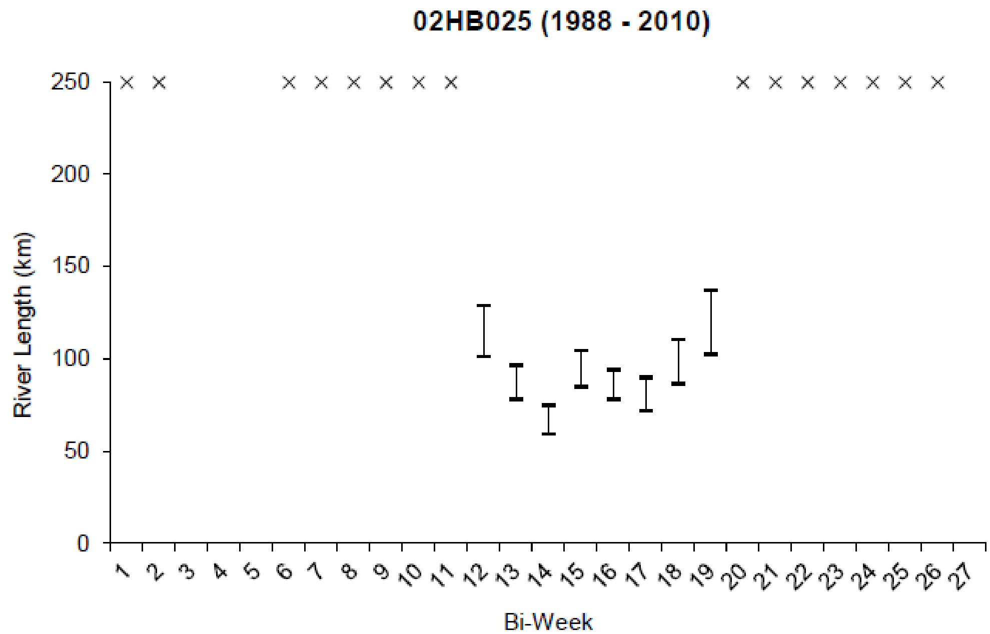


Figure A1-167. Gauging station 02HB032 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



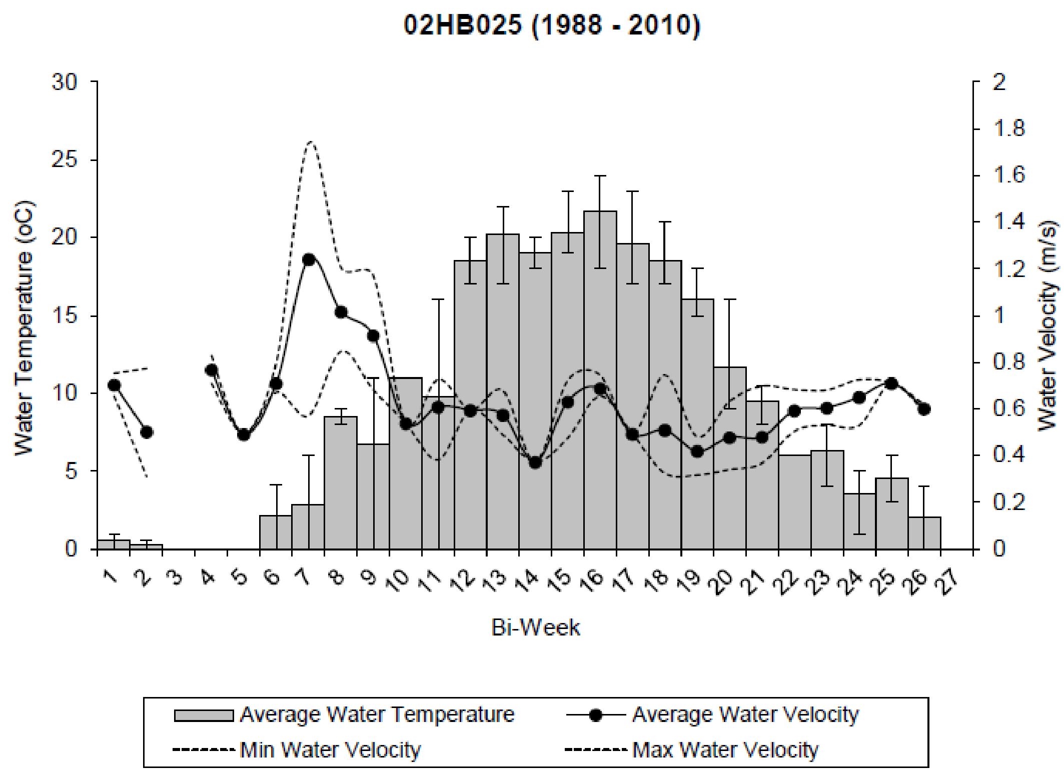


Figure A1-168. Gauging station 02HB025 data from 1988–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

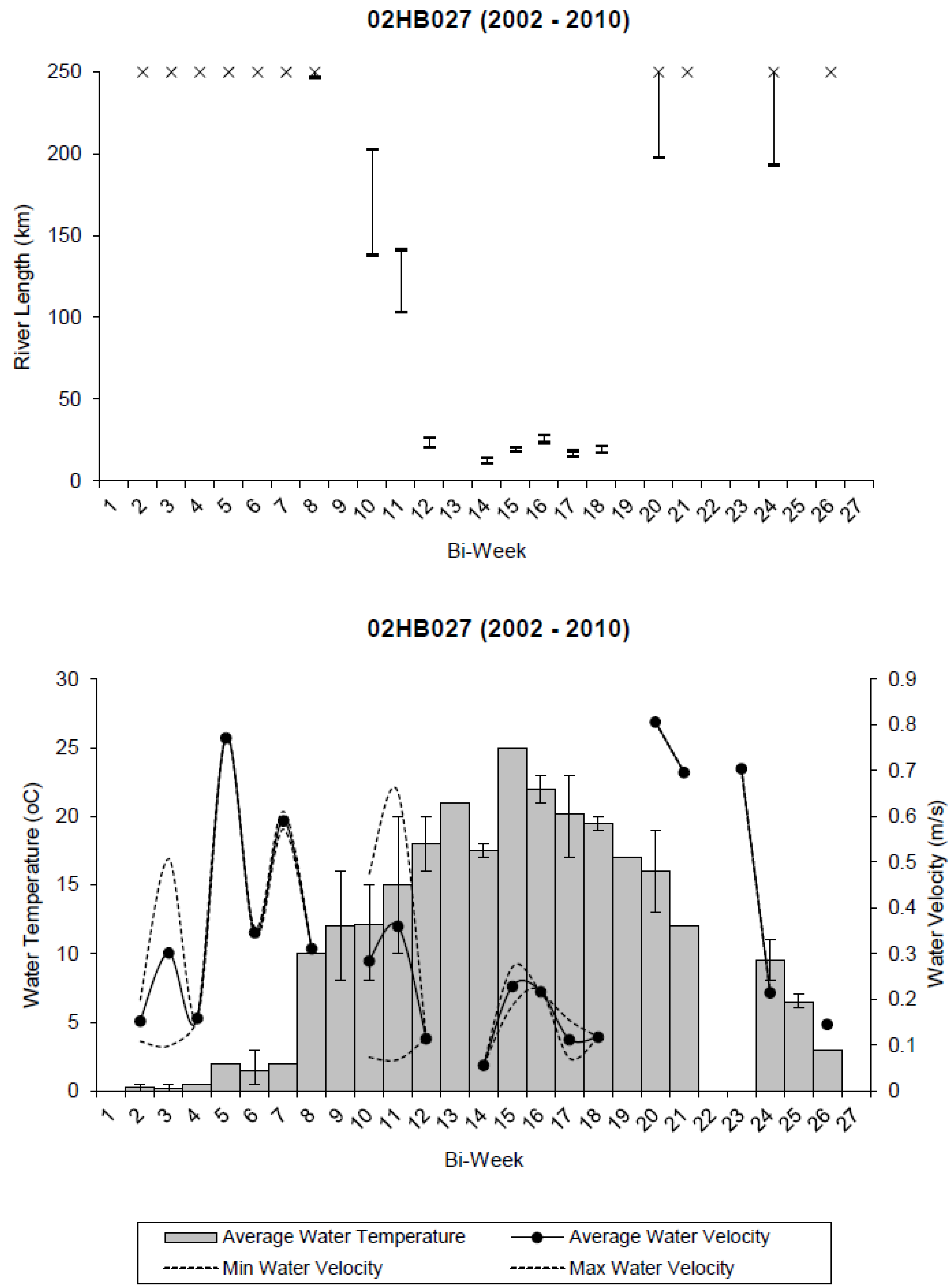


Figure A1-169. Gauging station 02HB027 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

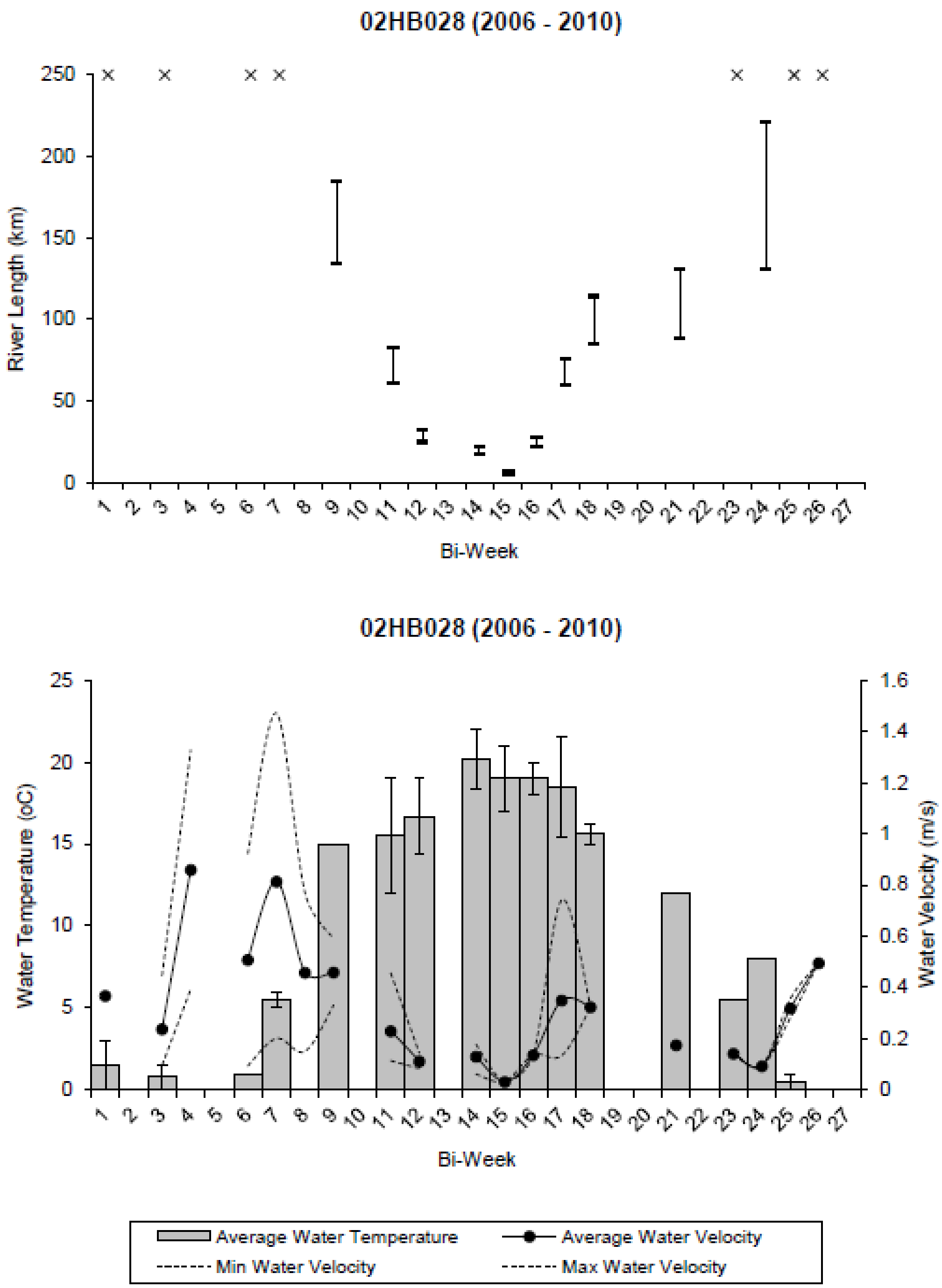
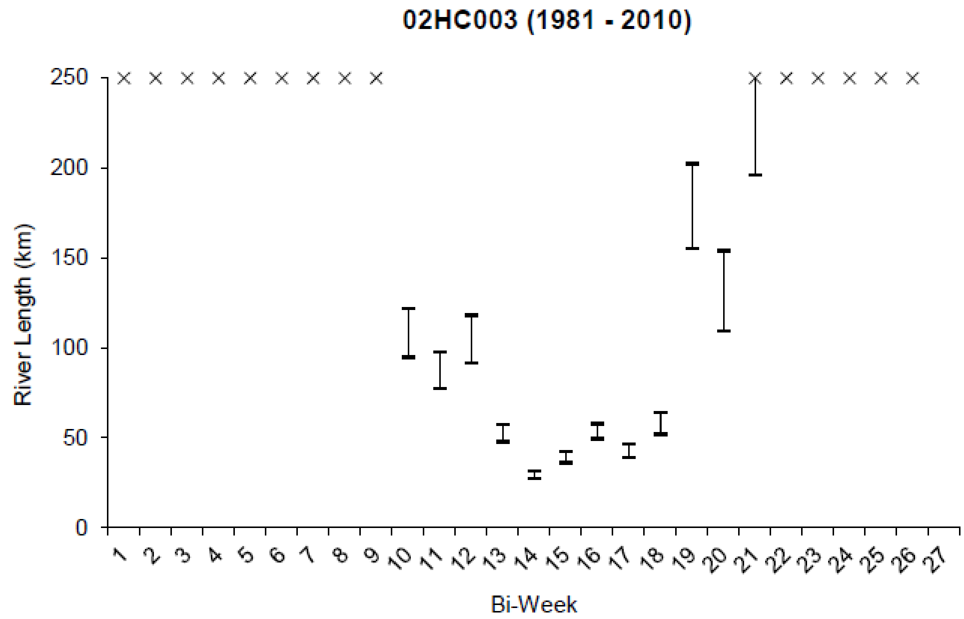


Figure A1-170. Gauging station 02HB028 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



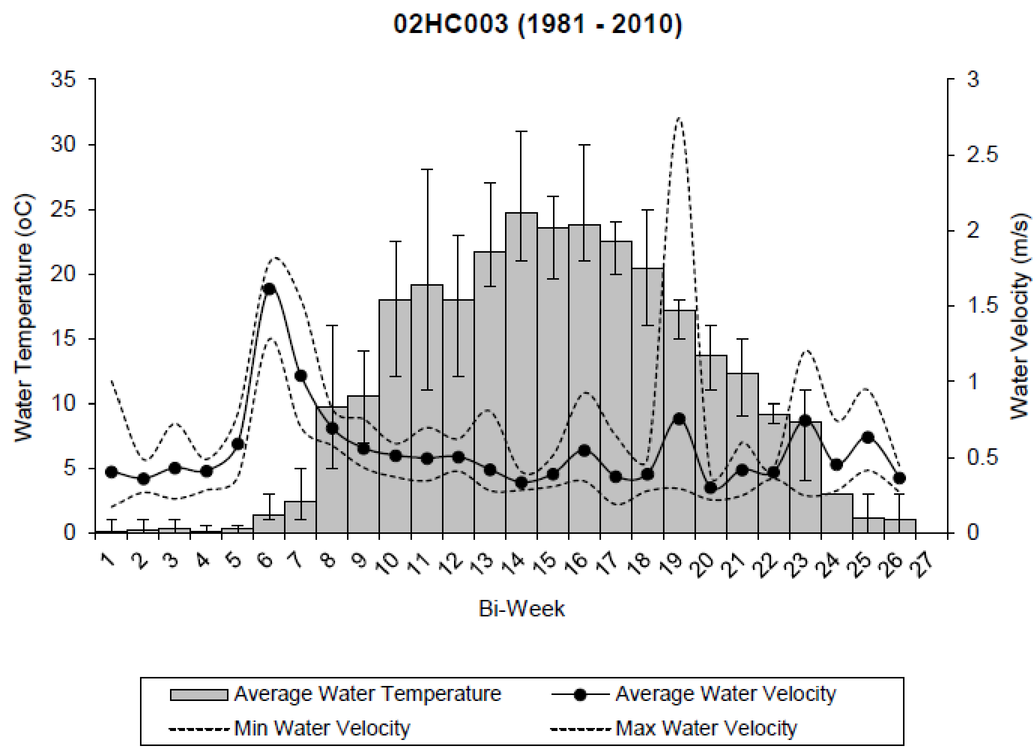
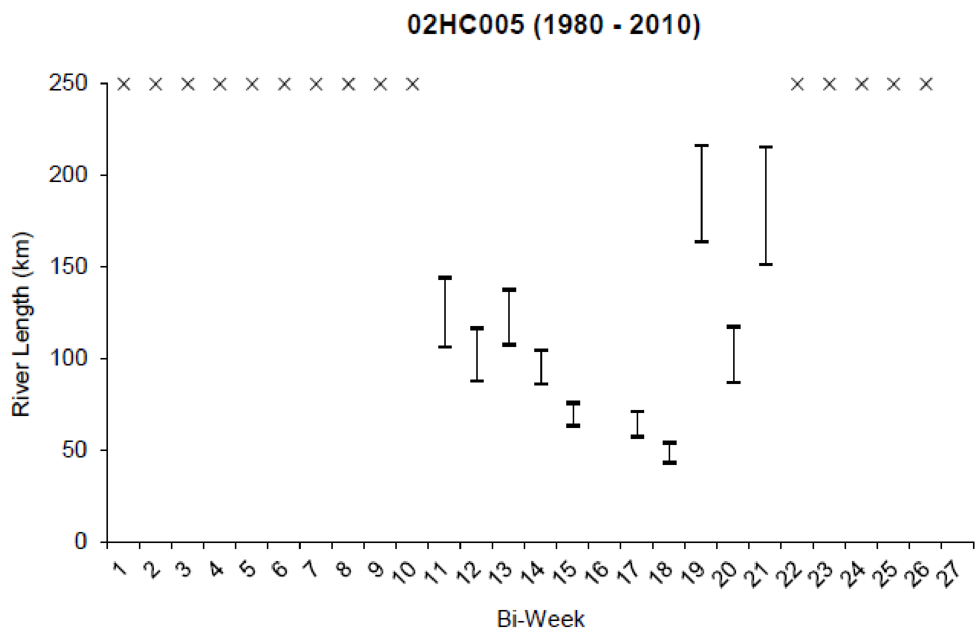


Figure A1-171. Gauging station 02HC003 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



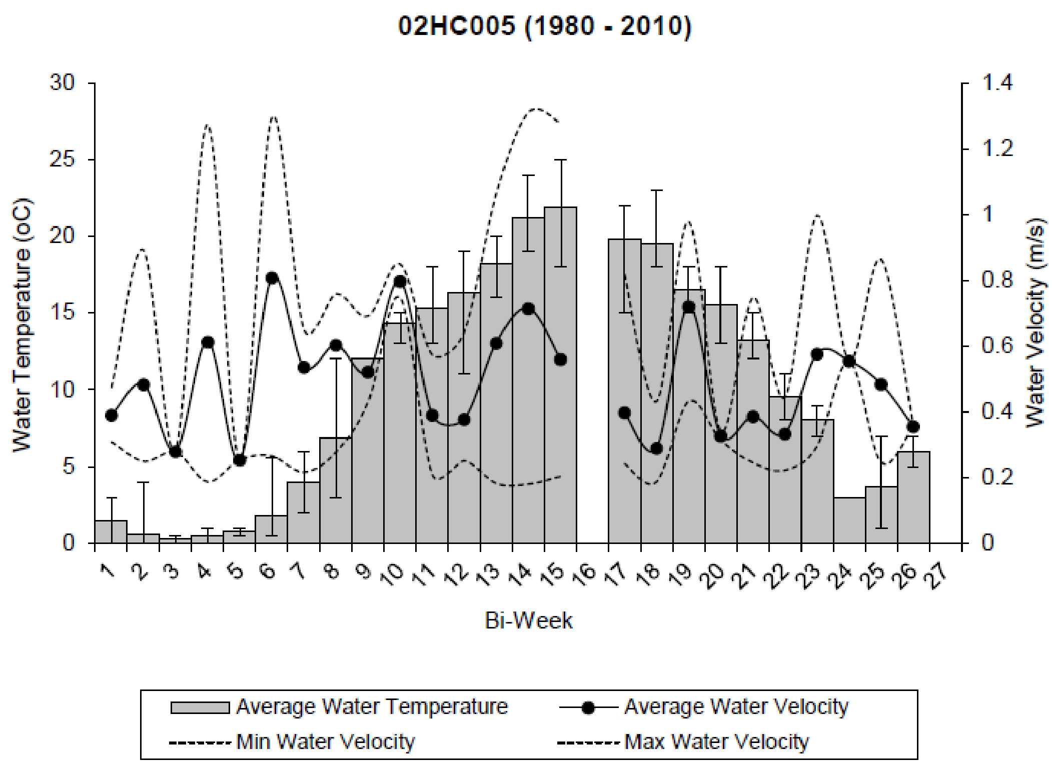
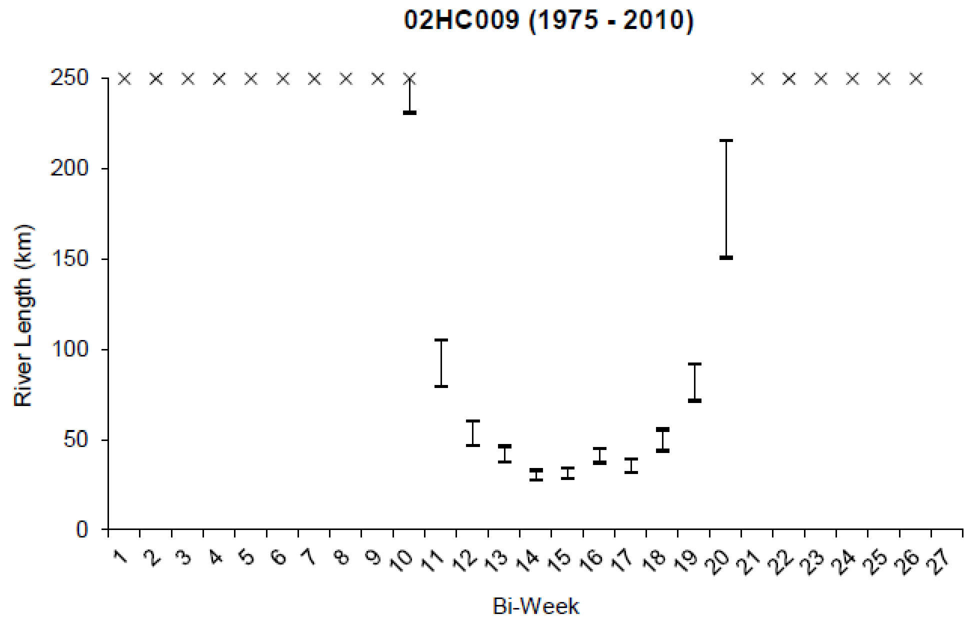


Figure A1-172. Gauging station 02HC005 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



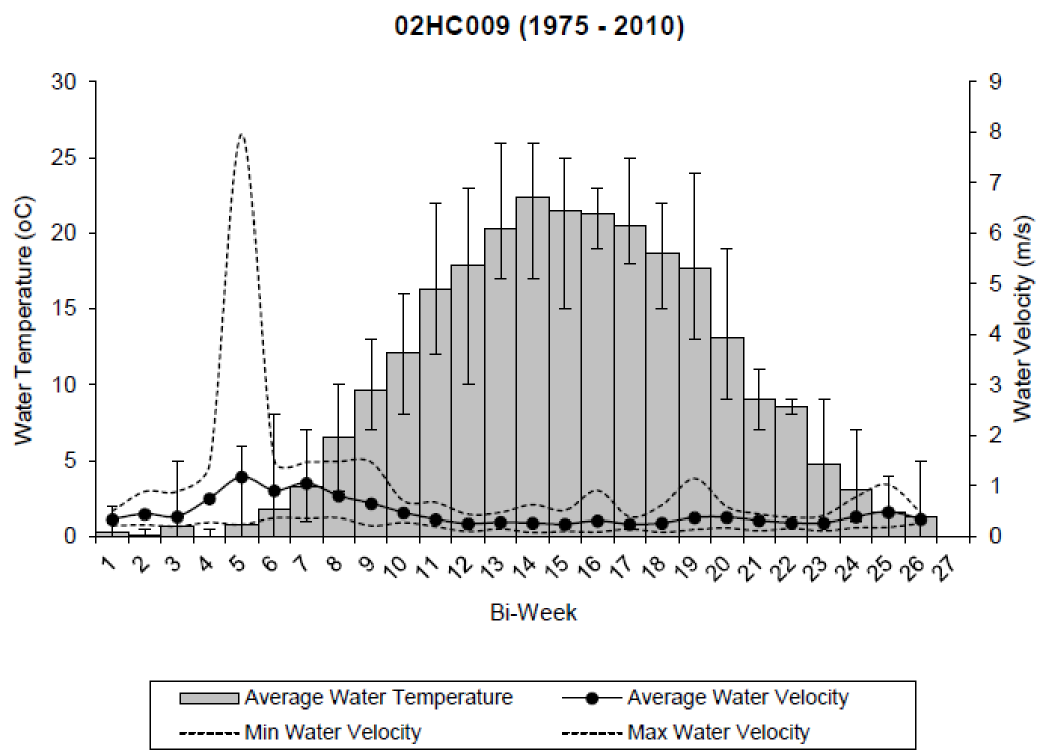


Figure A1-173. Gauging station 02HC009 data from 1975–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

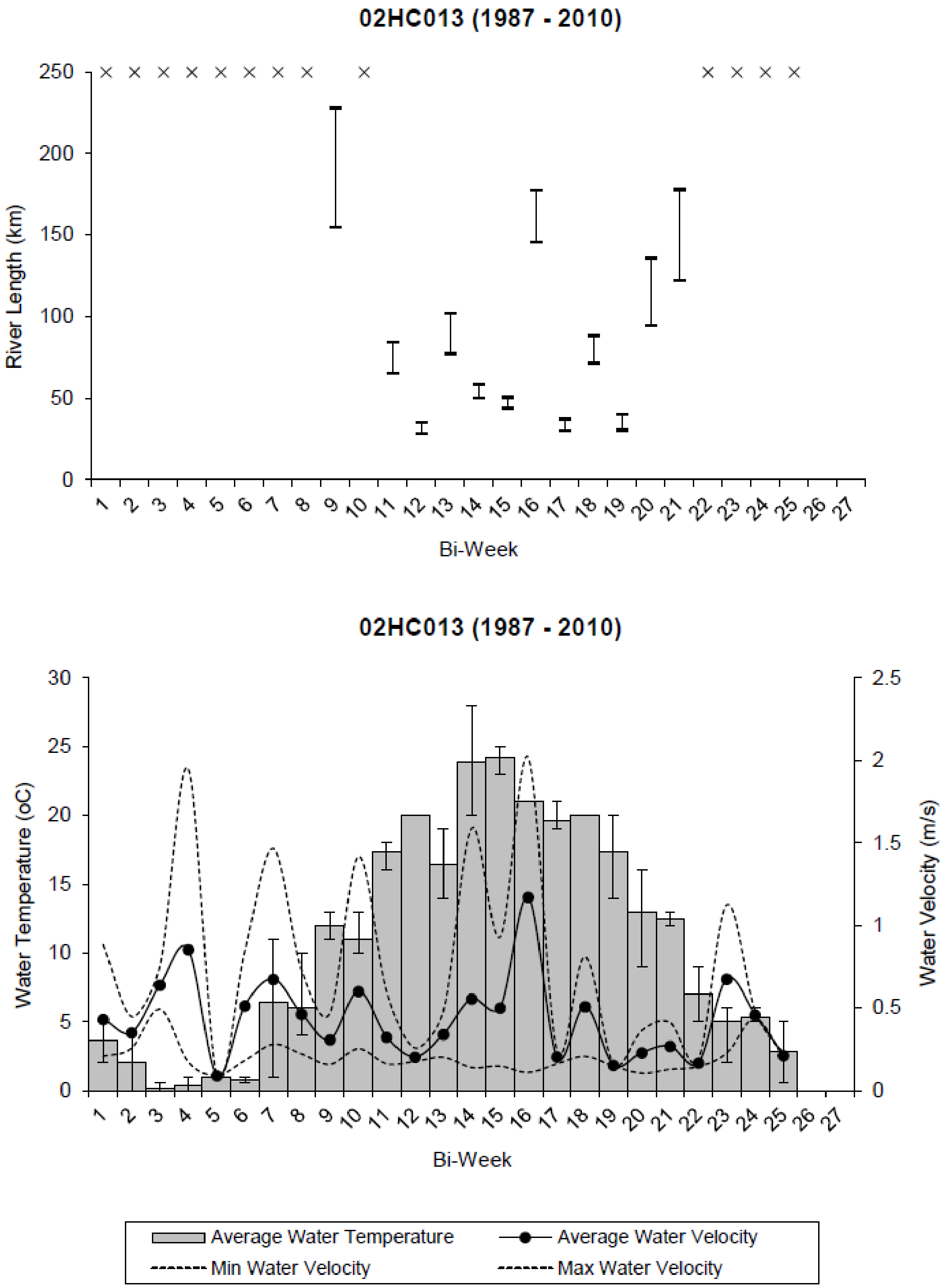
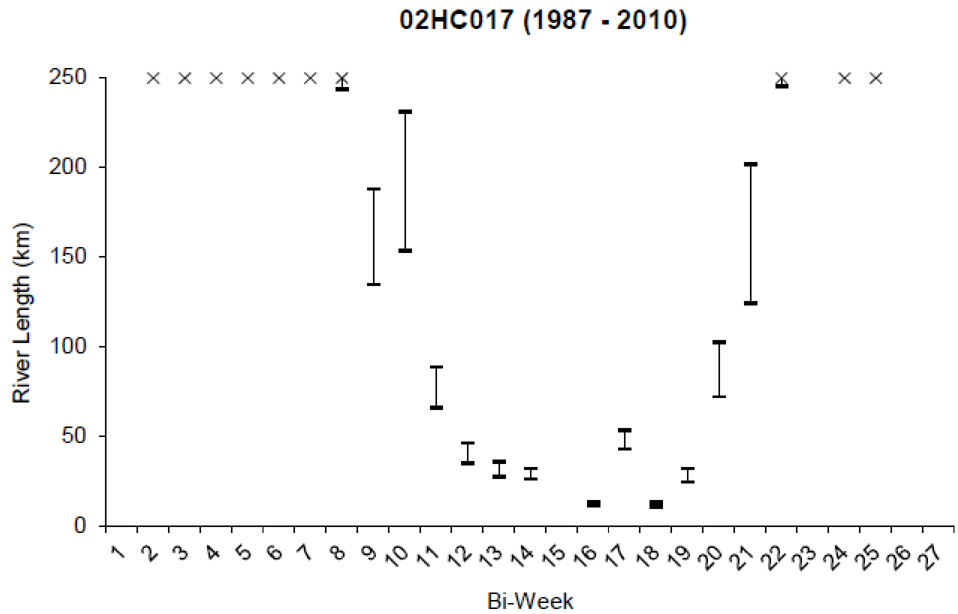


Figure A1-174. Gauging station 02HC013 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



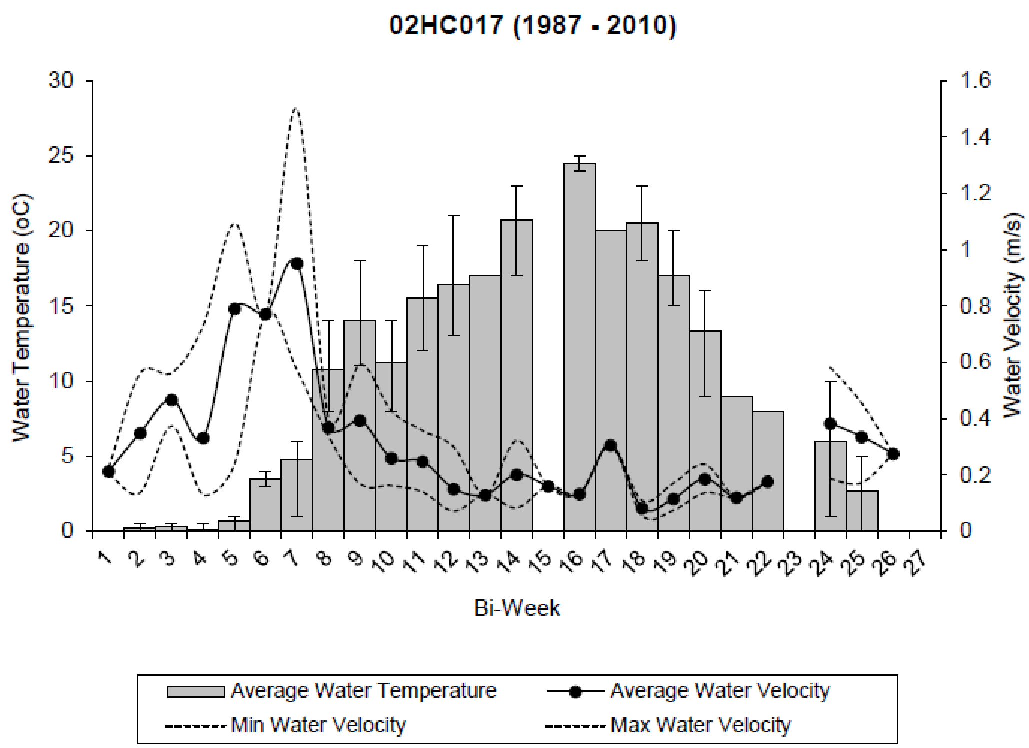
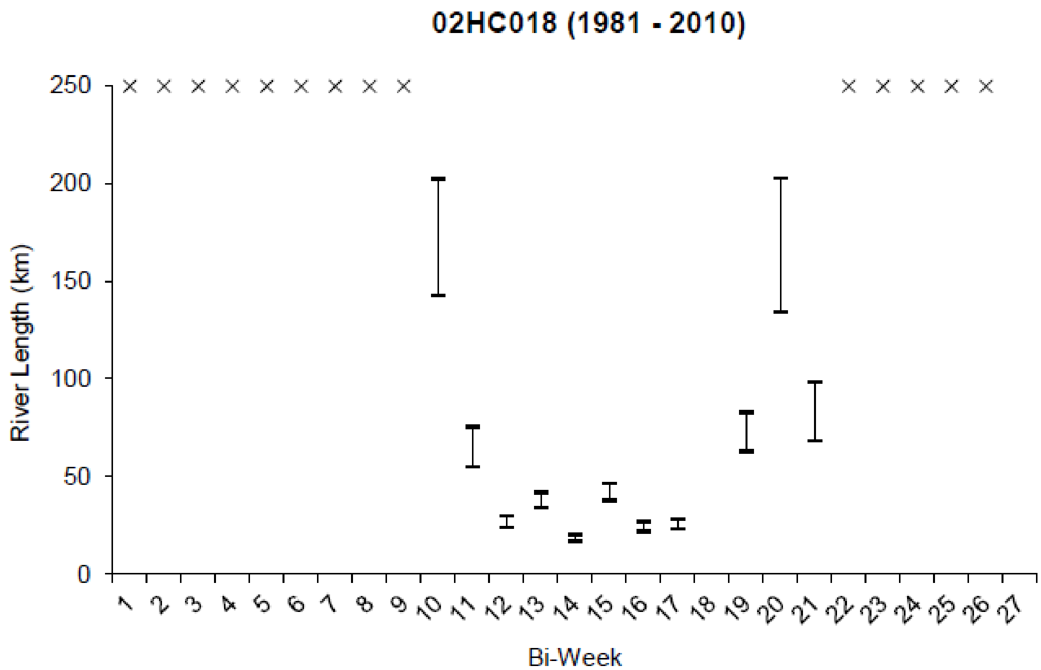


Figure A1-175. Gauging station 02HC017 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



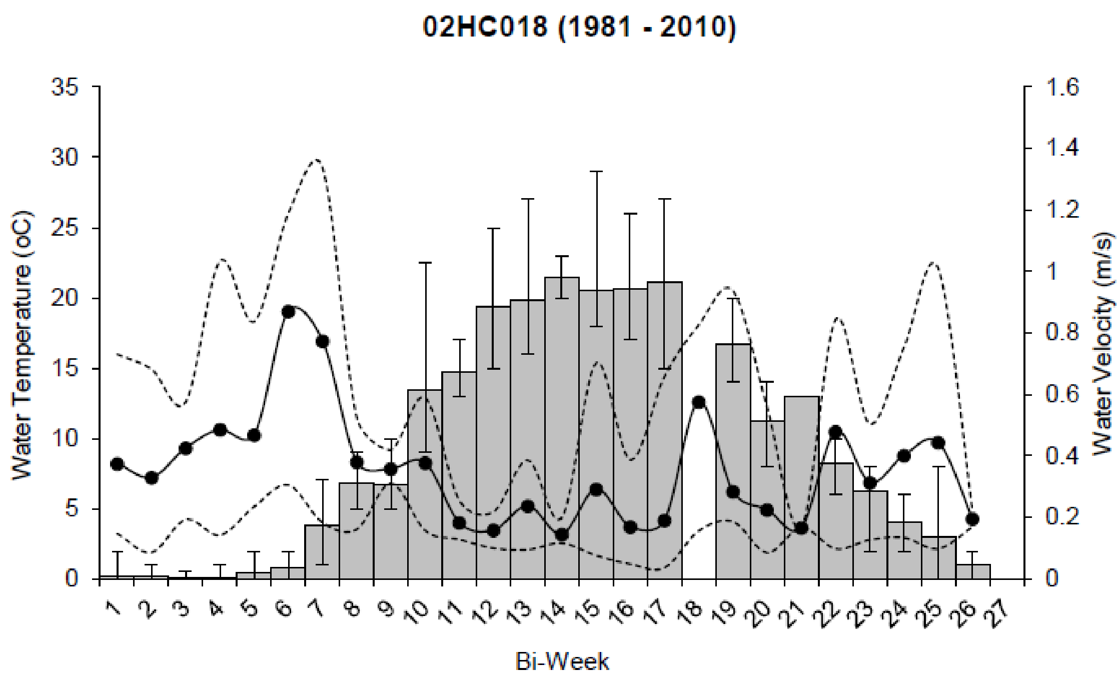


Figure A1-176. Gauging station 02HC018 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

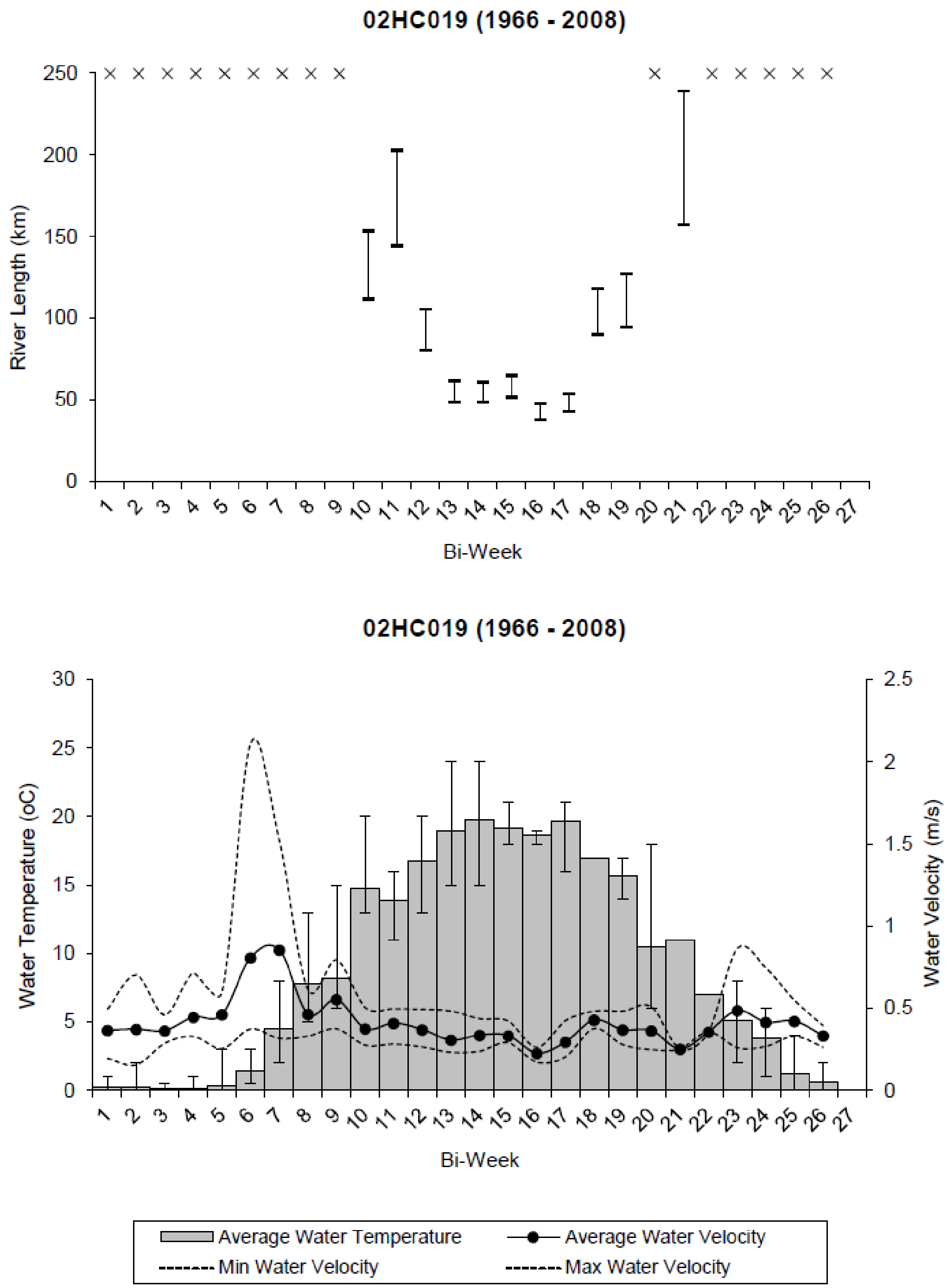
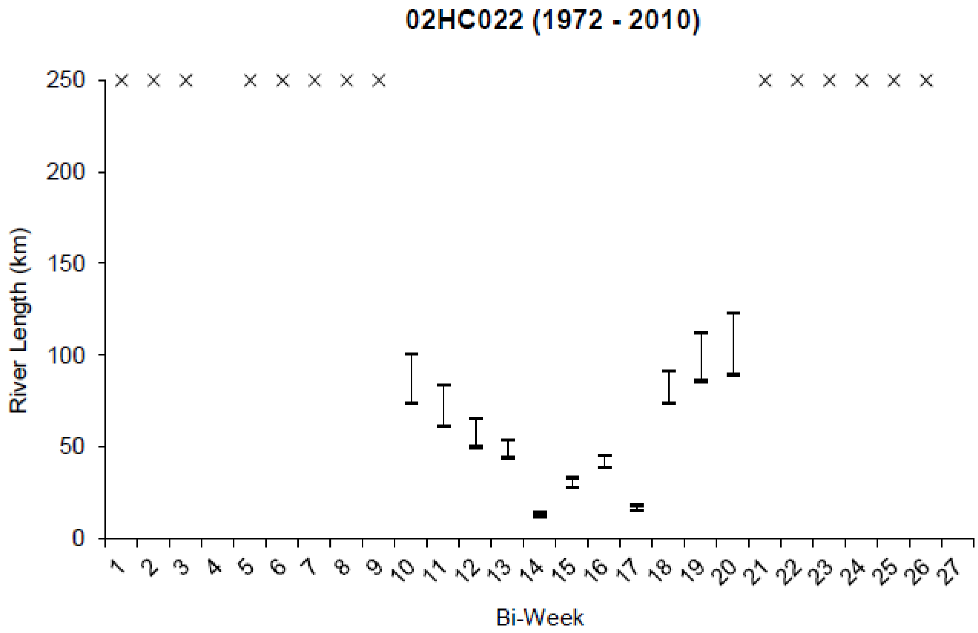


Figure A1-177. Gauging station 02HC019 data from 1966–2008. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



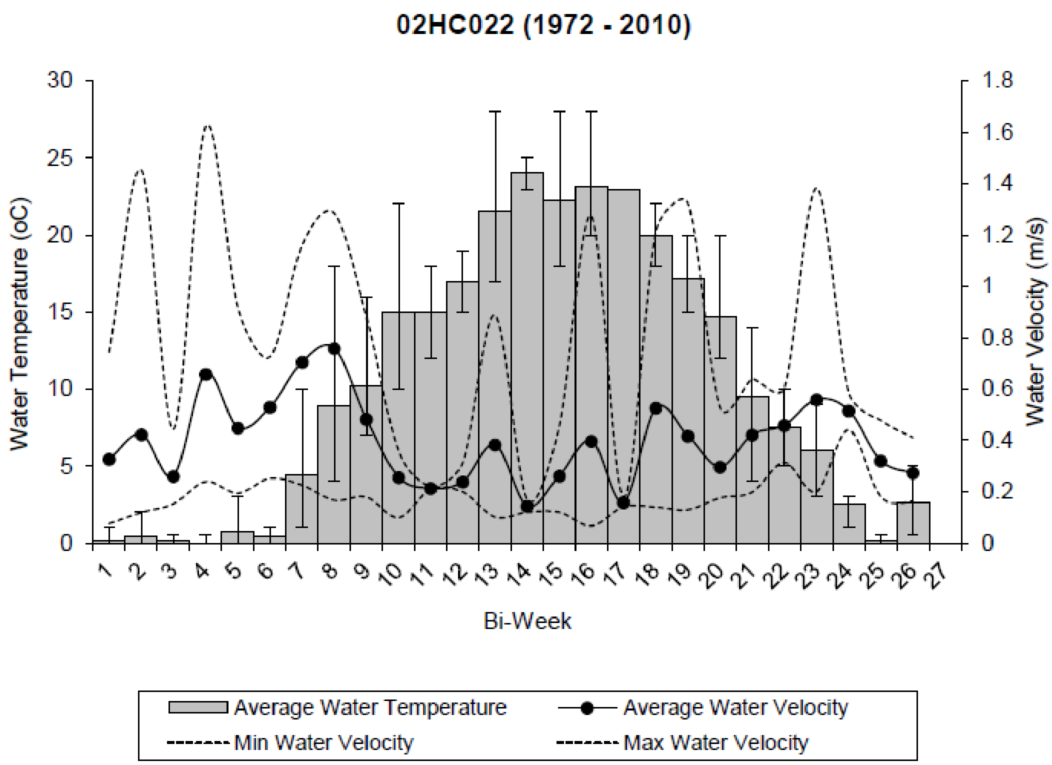
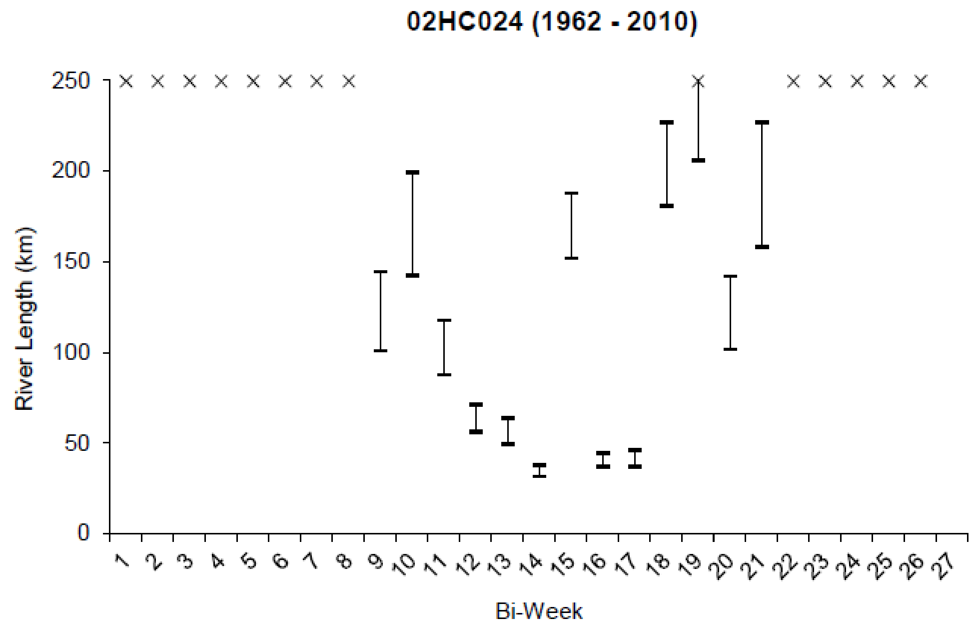


Figure A1-178. Gauging station 02HC022 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



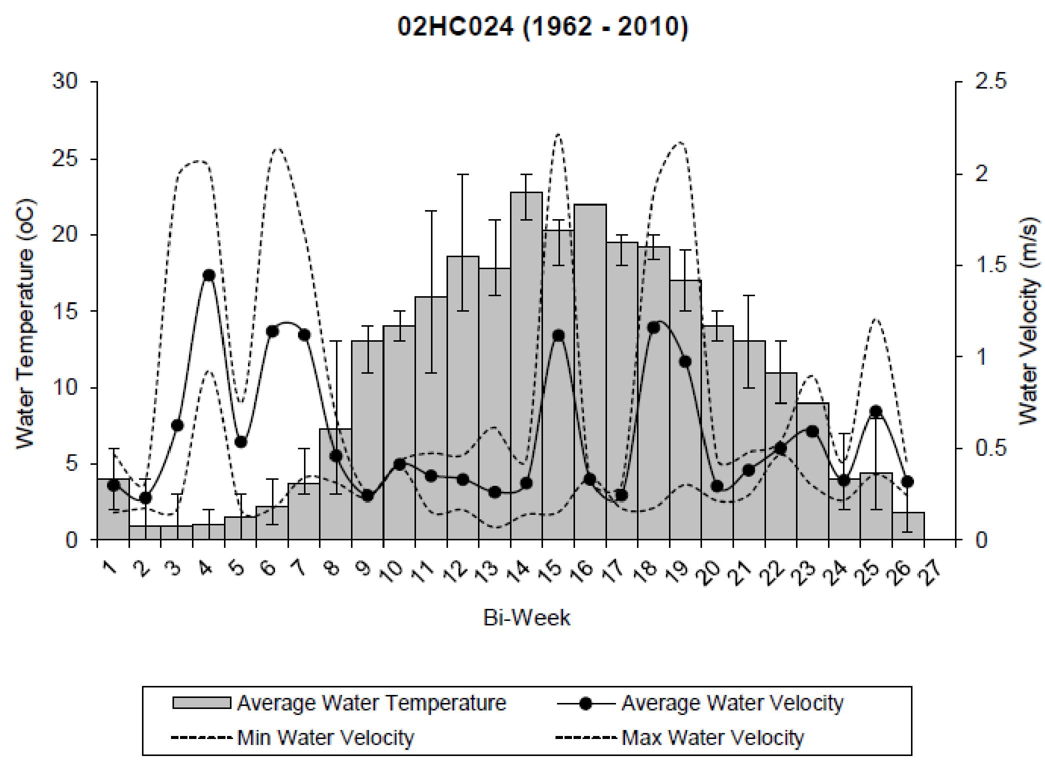


Figure A1-179. Gauging station 02HC024 data from 1962–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

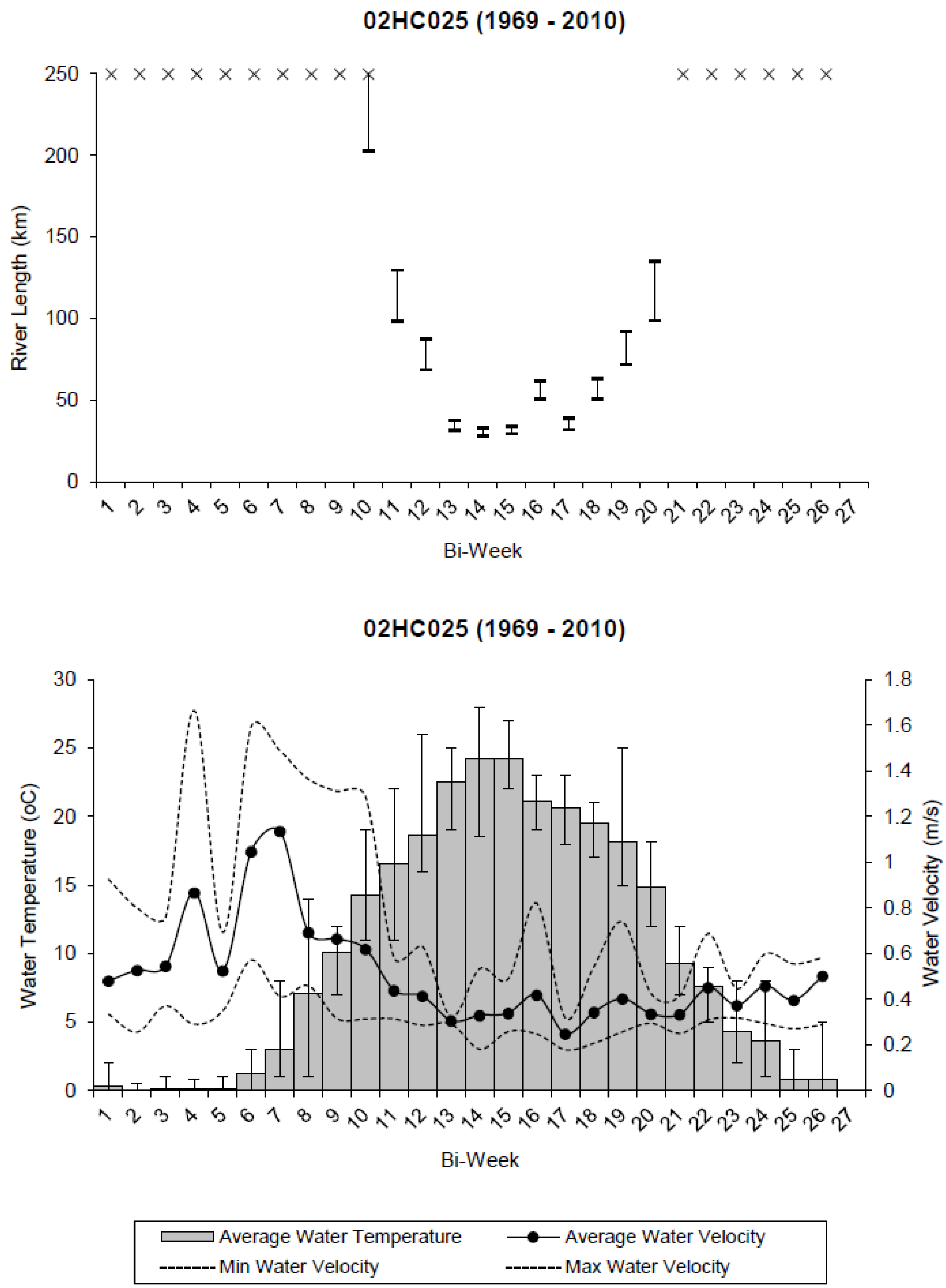
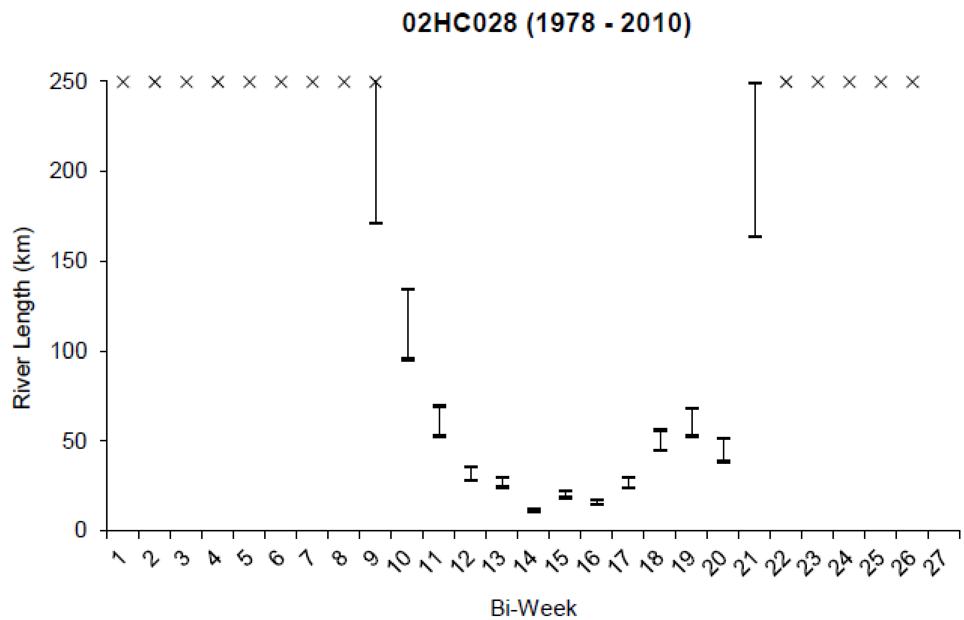


Figure A1-180. Gauging station 02HC025 data from 1969–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



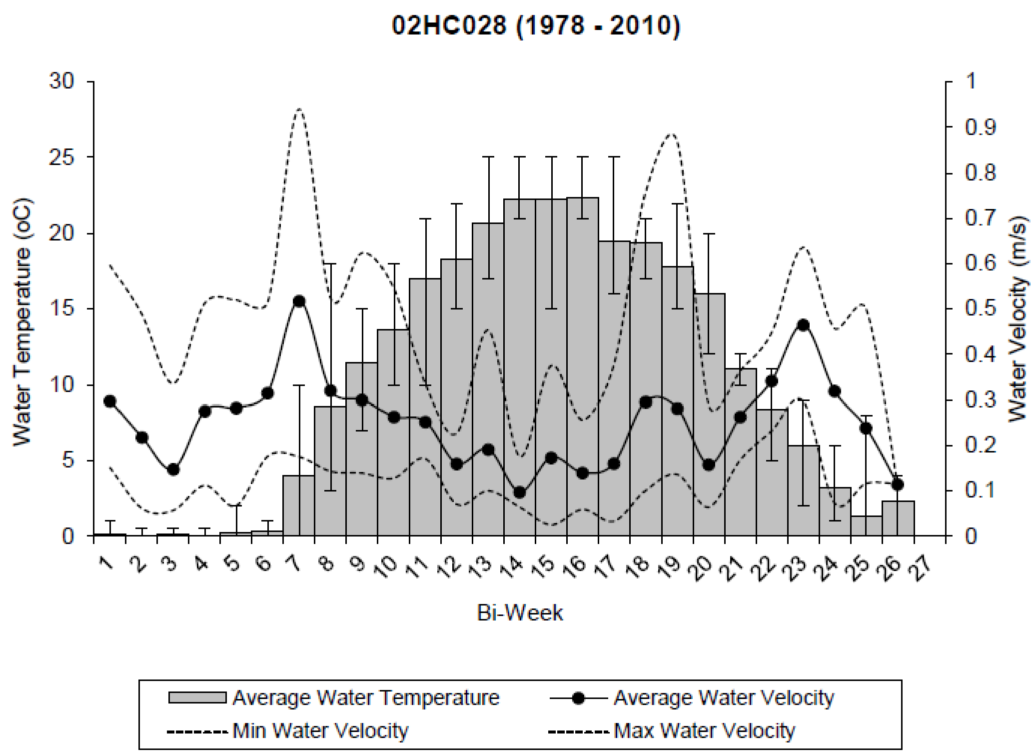
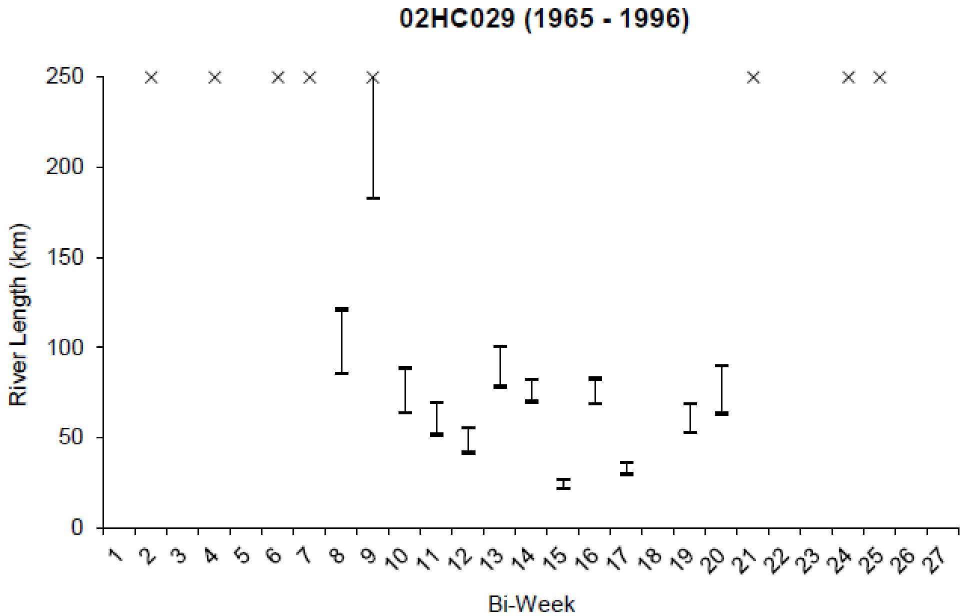


Figure A1-181. Gauging station 02HC028 data from 1978–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



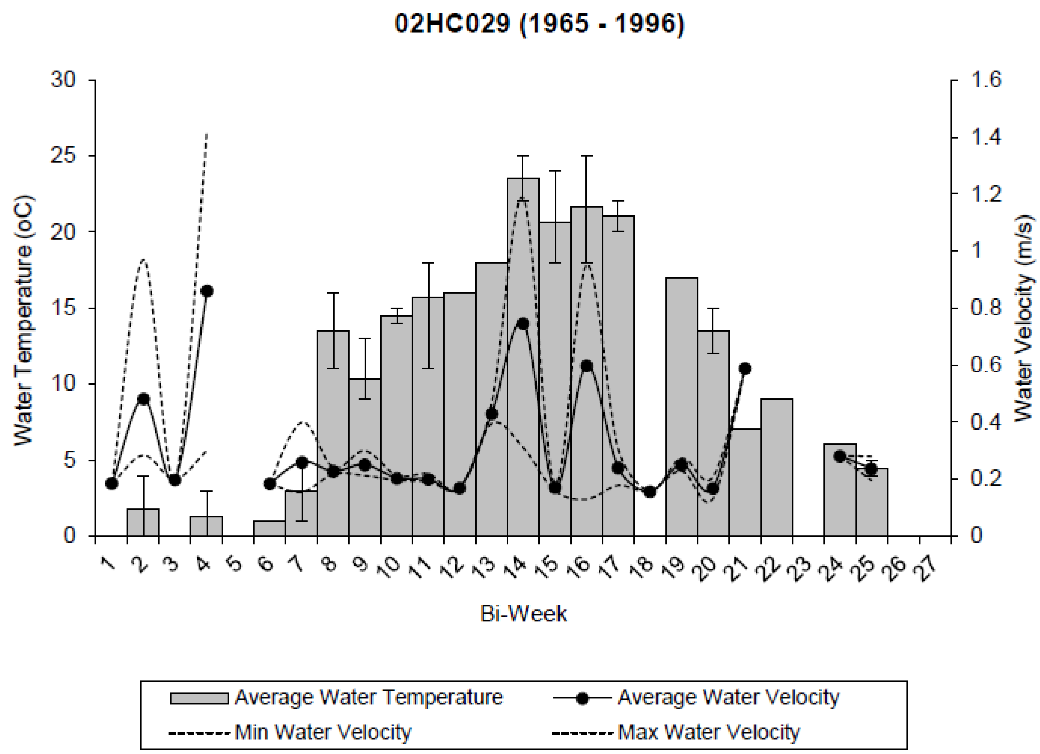
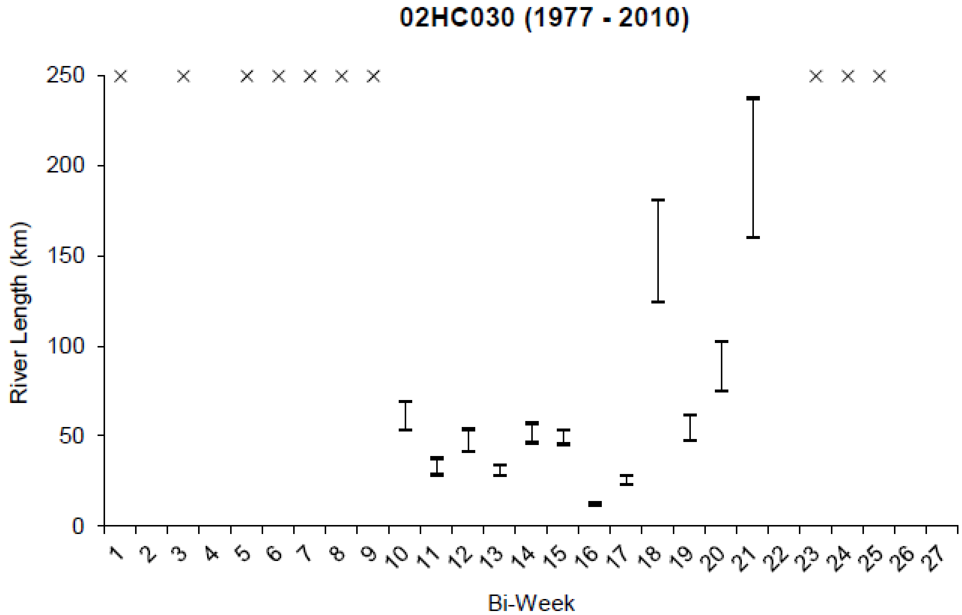


Figure A1-182. Gauging station 02HC029 data from 1965–1996. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



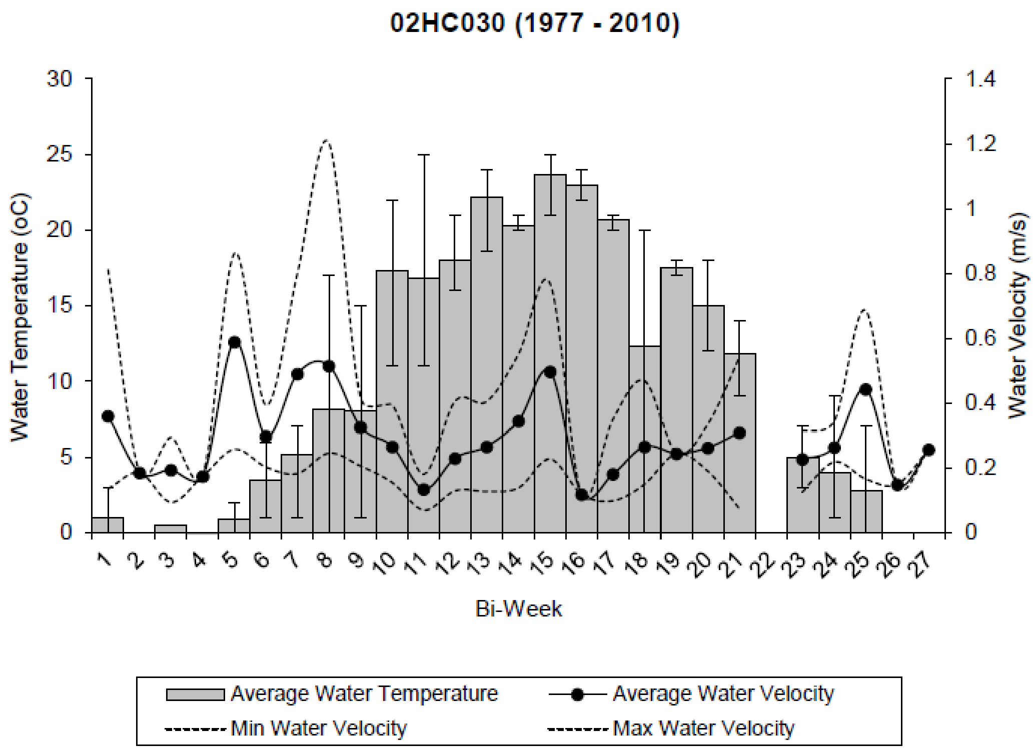


Figure A1-183. Gauging station 02HC030 data from 1977–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

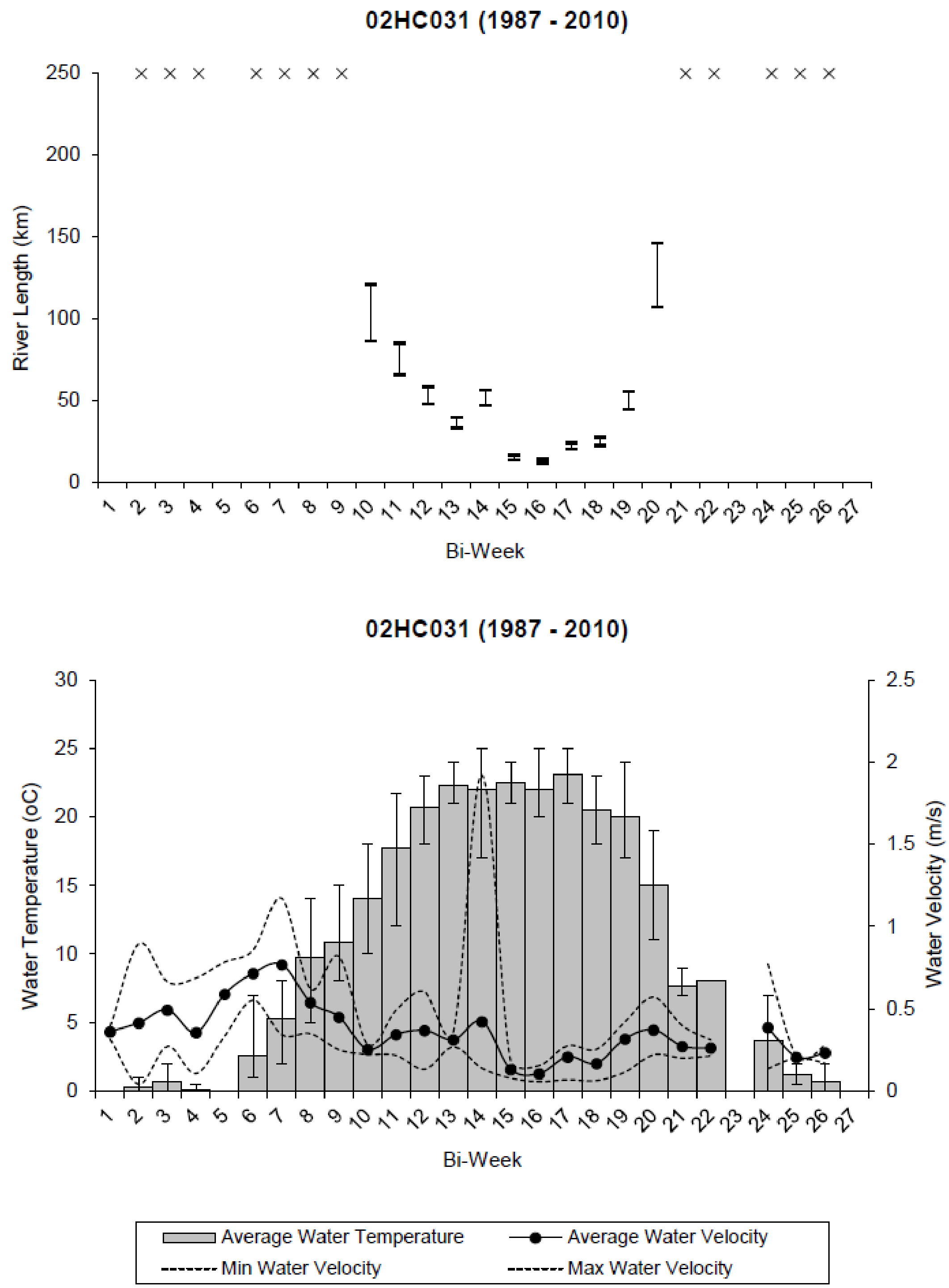
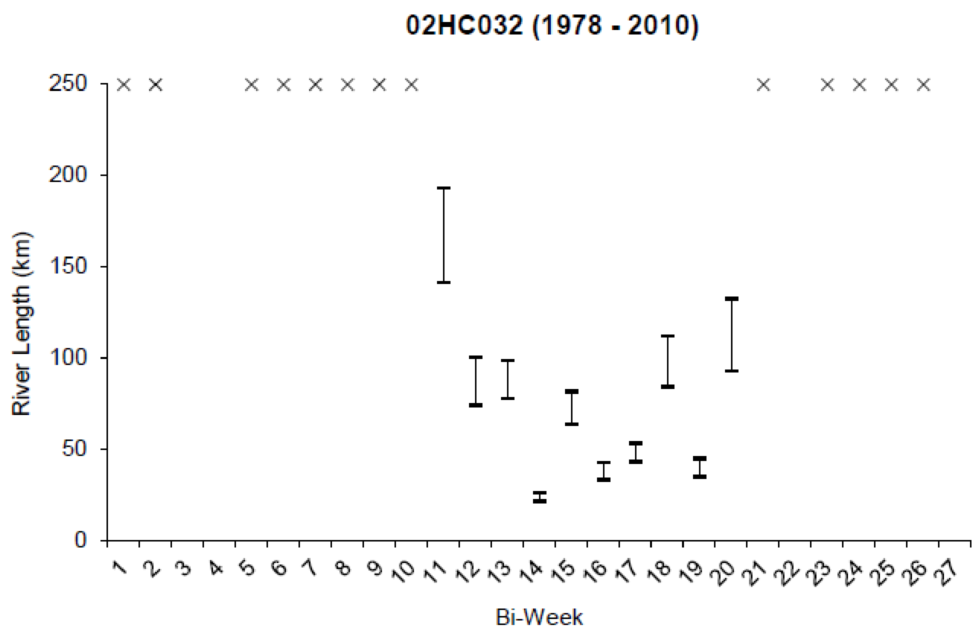


Figure A1-184. Gauging station 02HC031 data from 1987–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



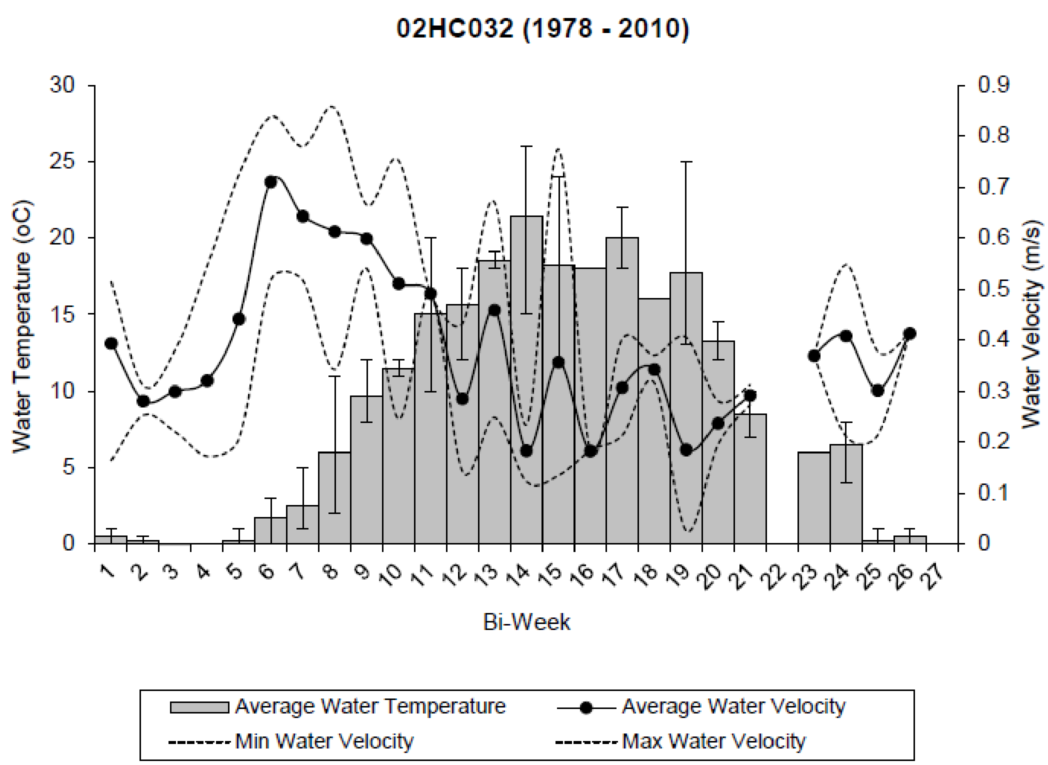
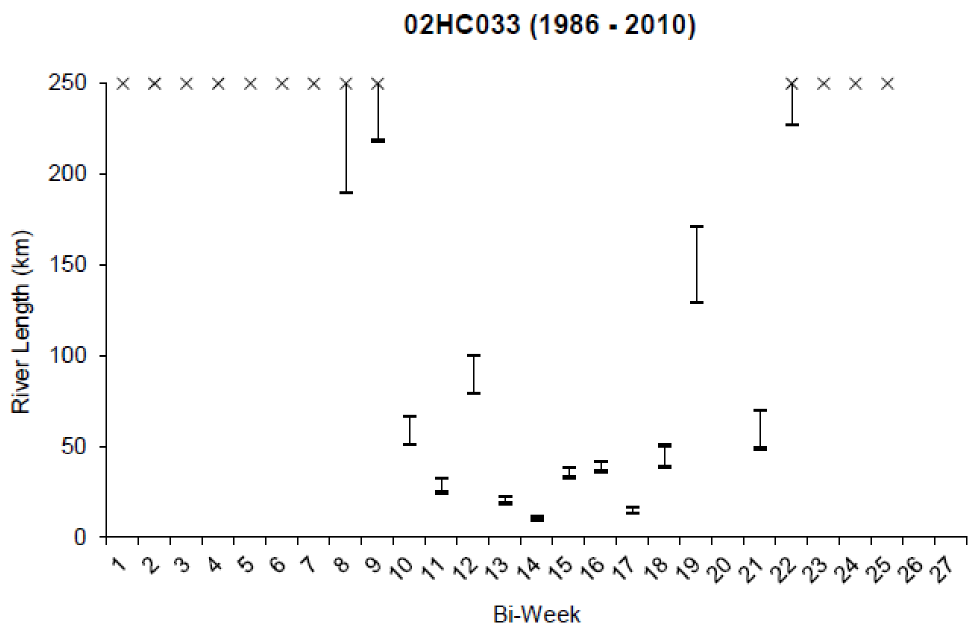


Figure A1-185. Gauging station 02HC032 data from 1978–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



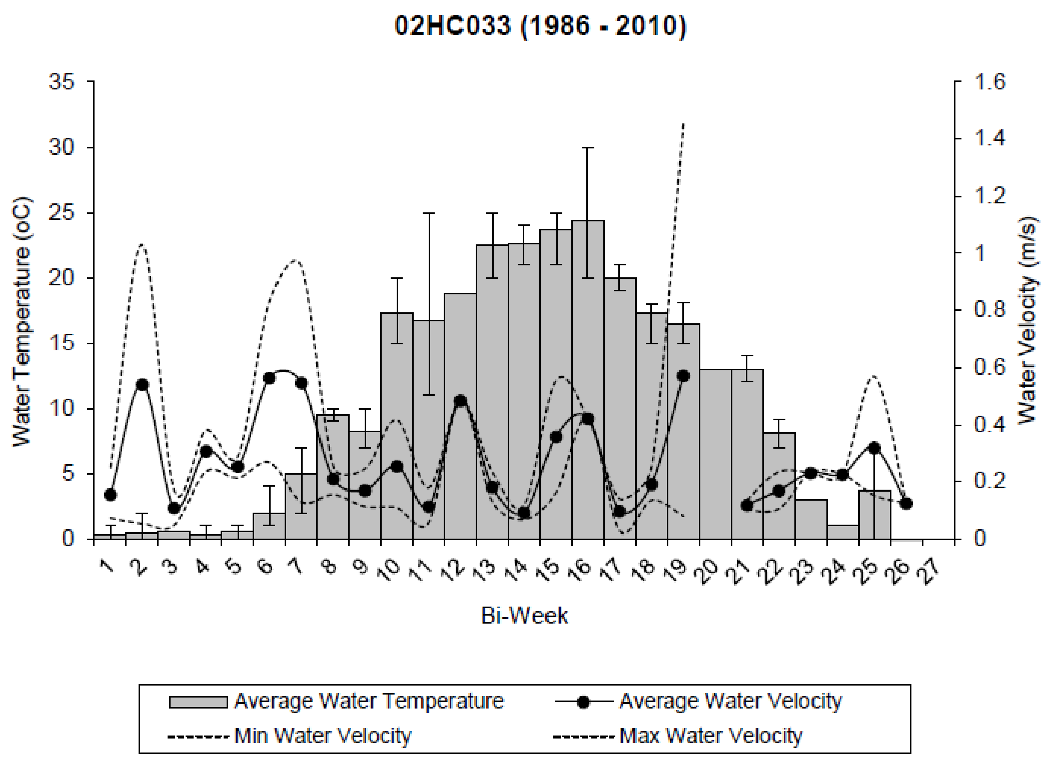


Figure A1-186. Gauging station 02HC033 data from 1986–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

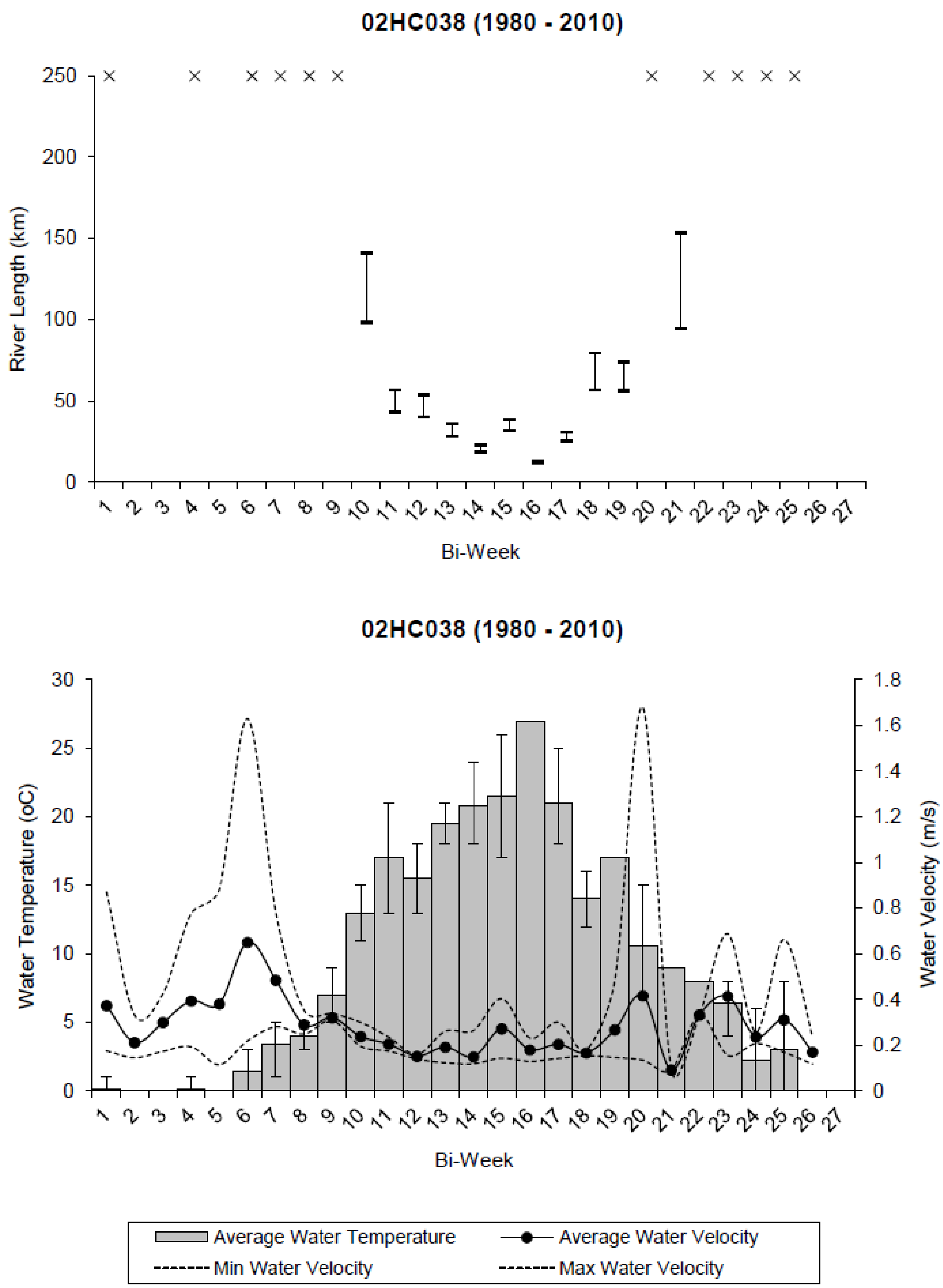
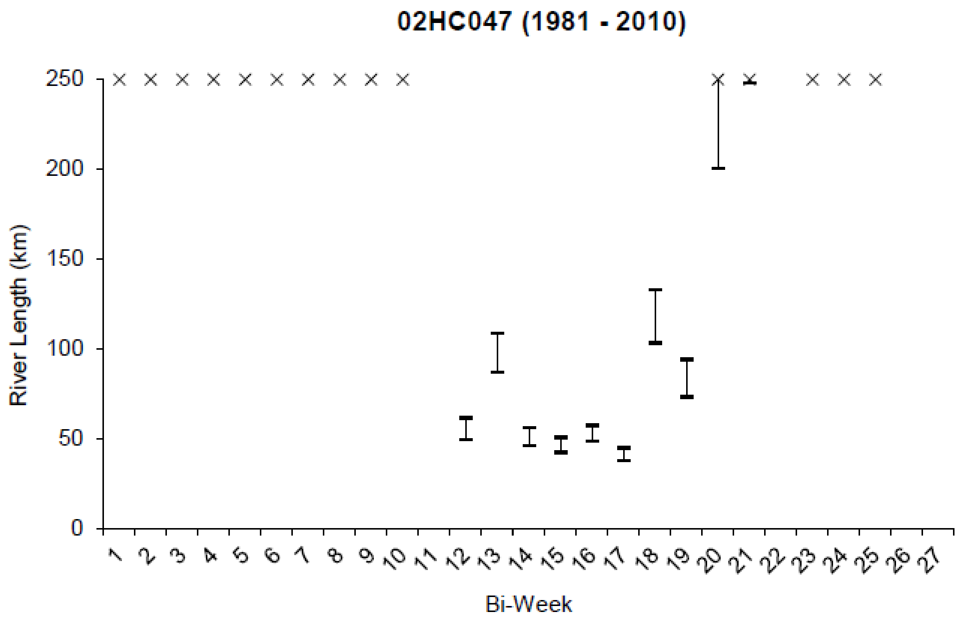


Figure A1-187. Gauging station 02HC038 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



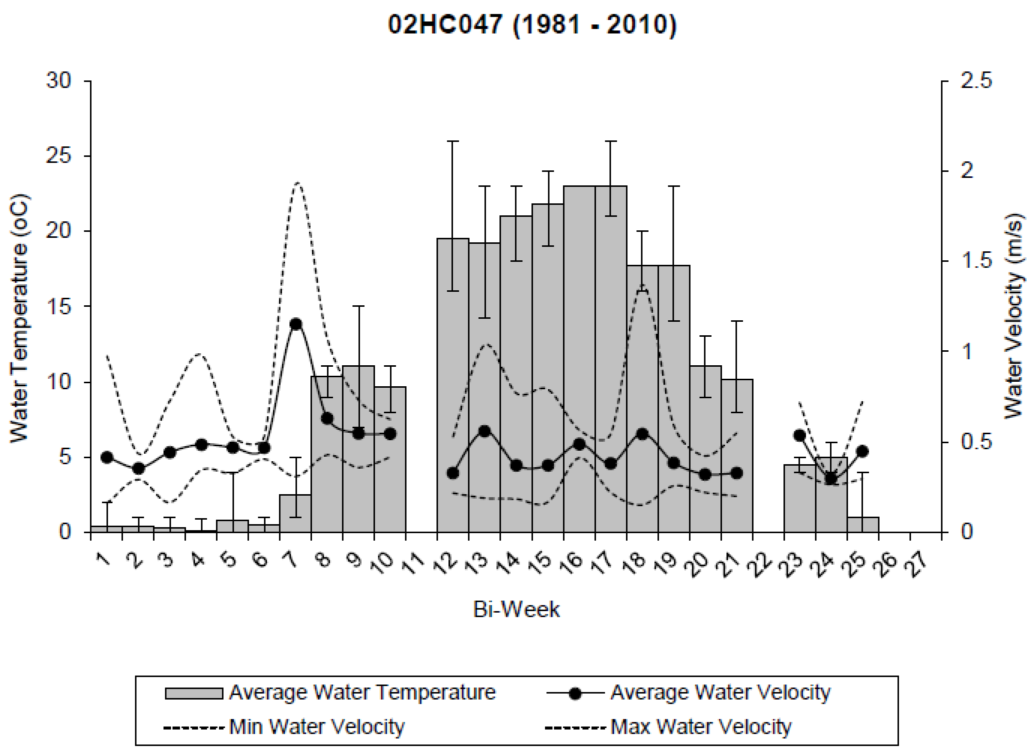
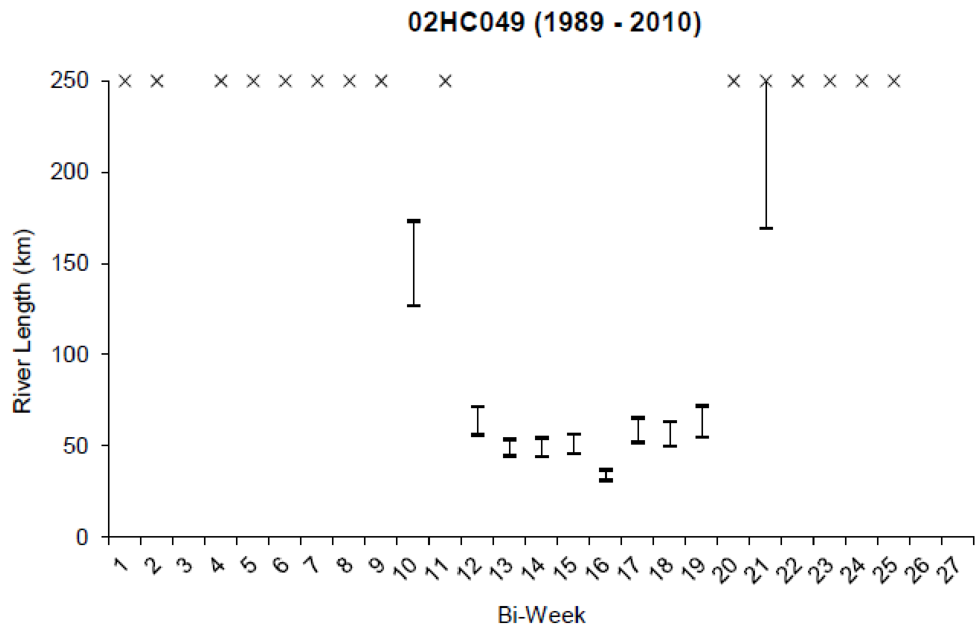


Figure A1-188. Gauging station 02HC047 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



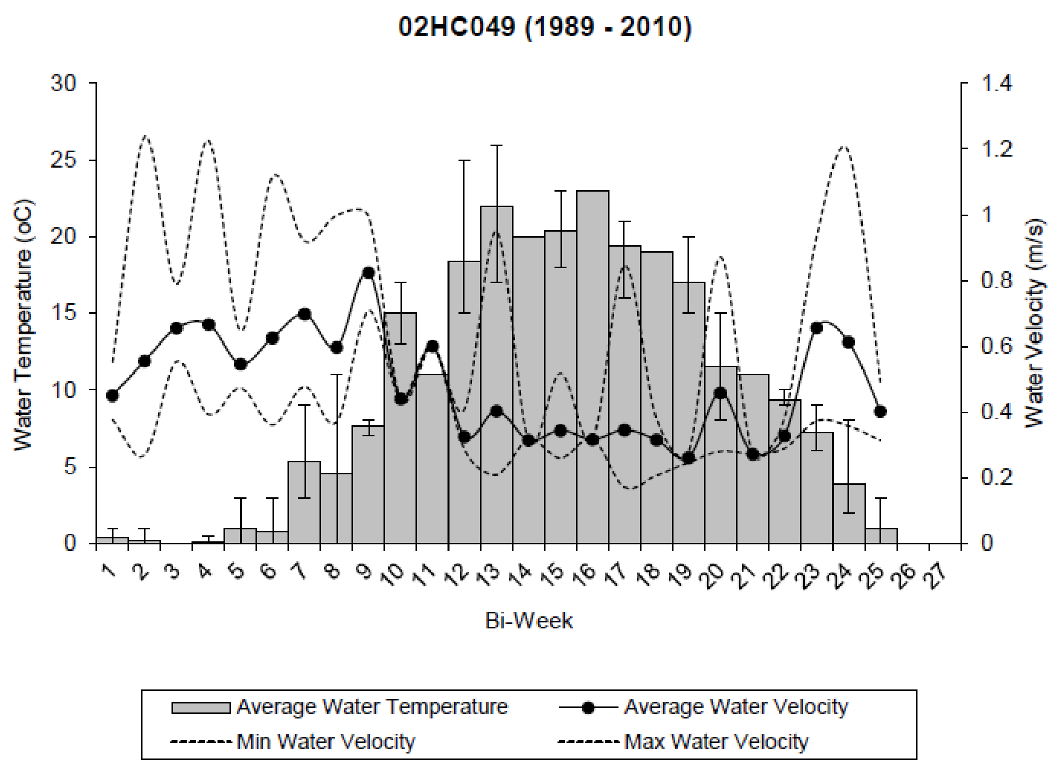


Figure A1-189. Gauging station 02HC049 data from 1989–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

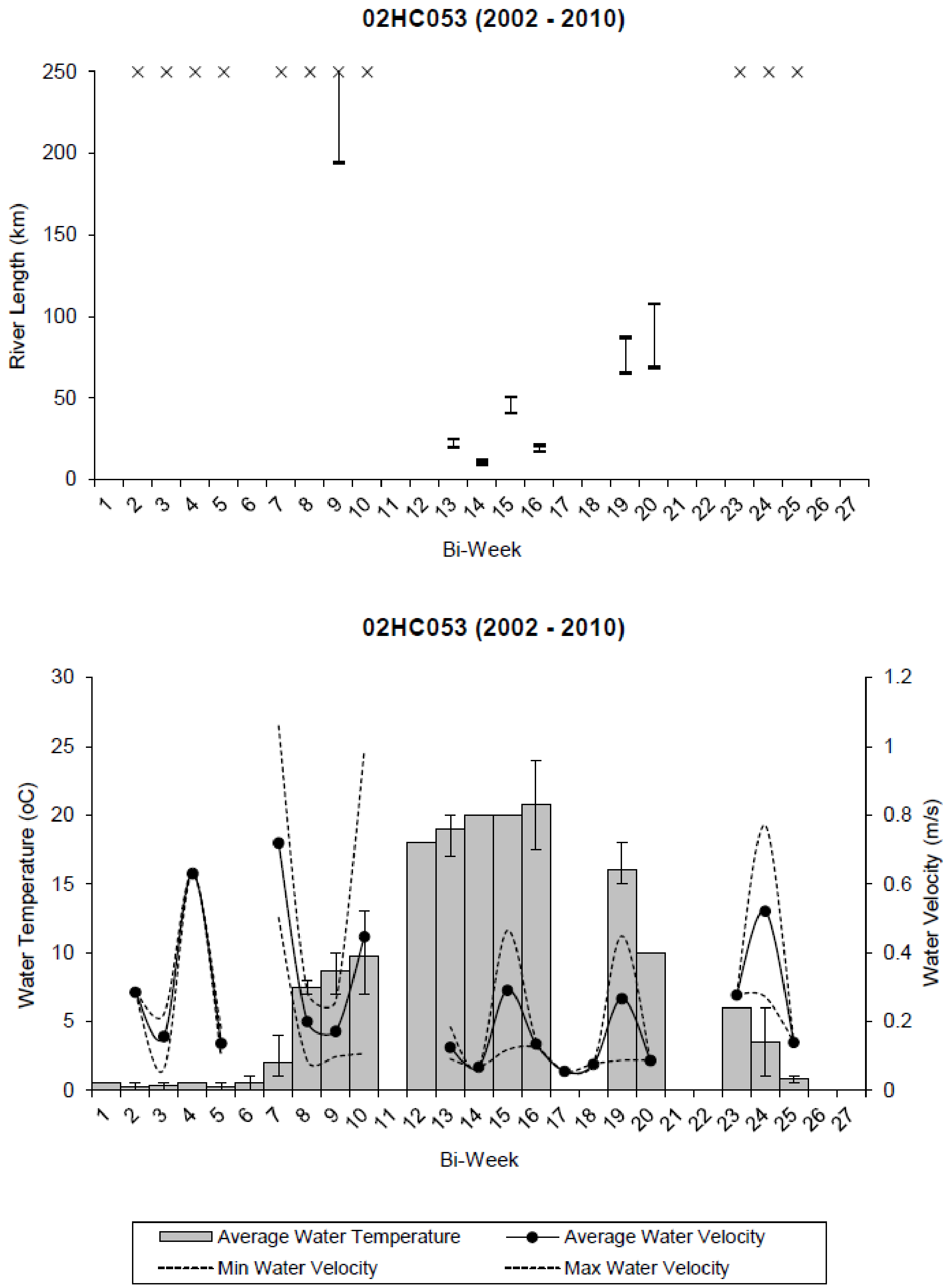
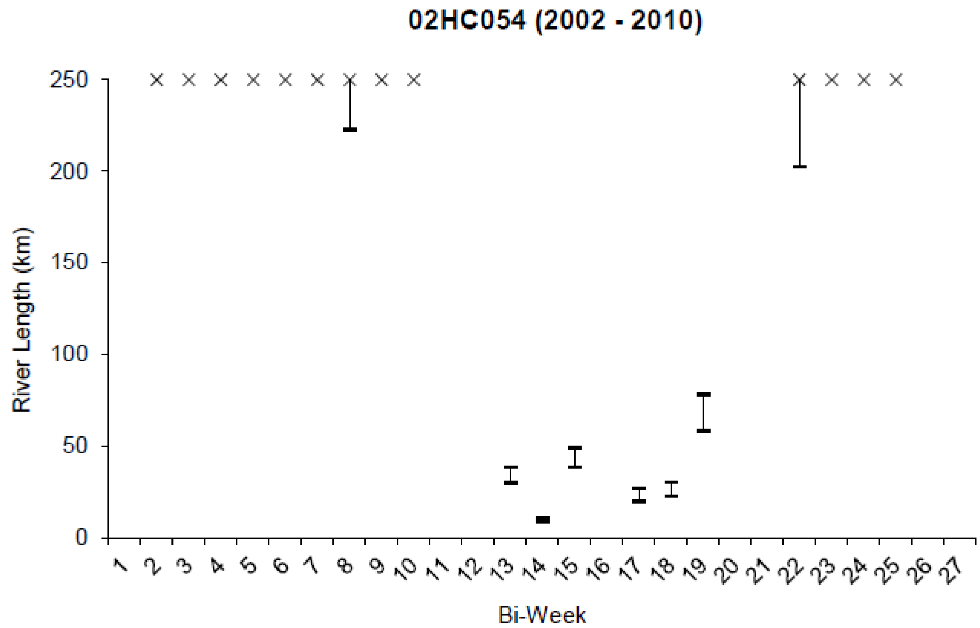


Figure A1-190. Gauging station 02HC053 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



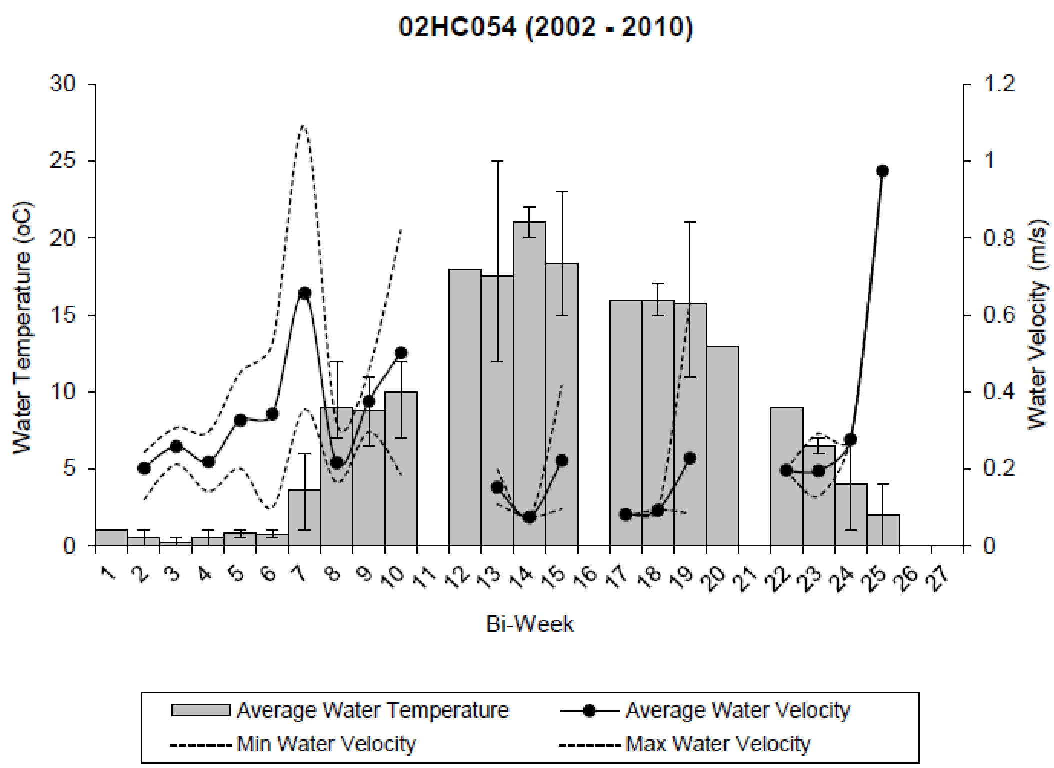
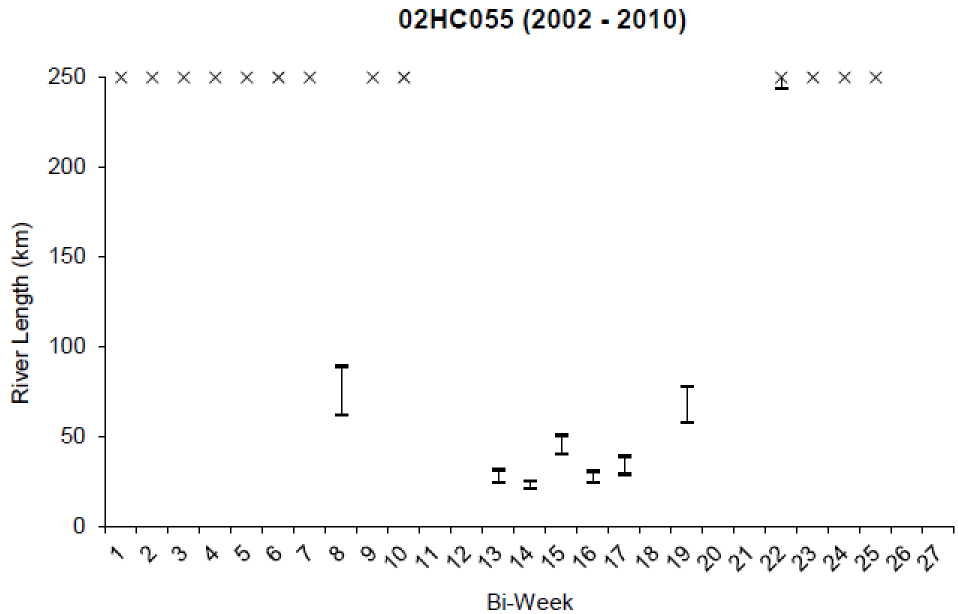


Figure A1-191. Gauging station 02HC054 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



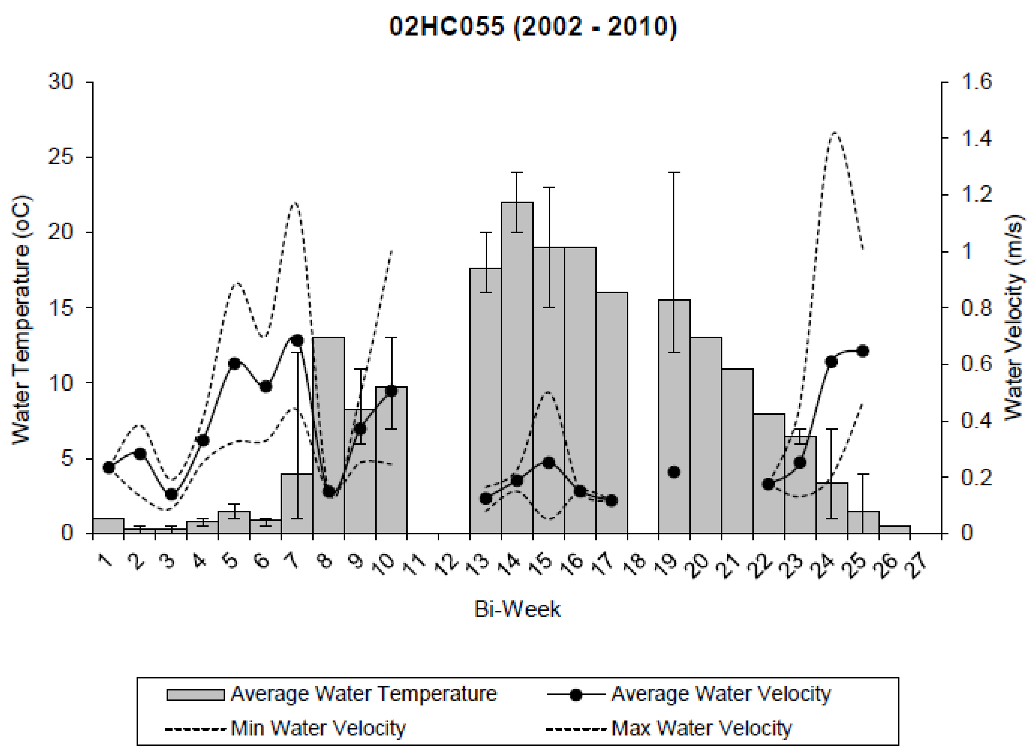


Figure A1-192. Gauging station 02HC055 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

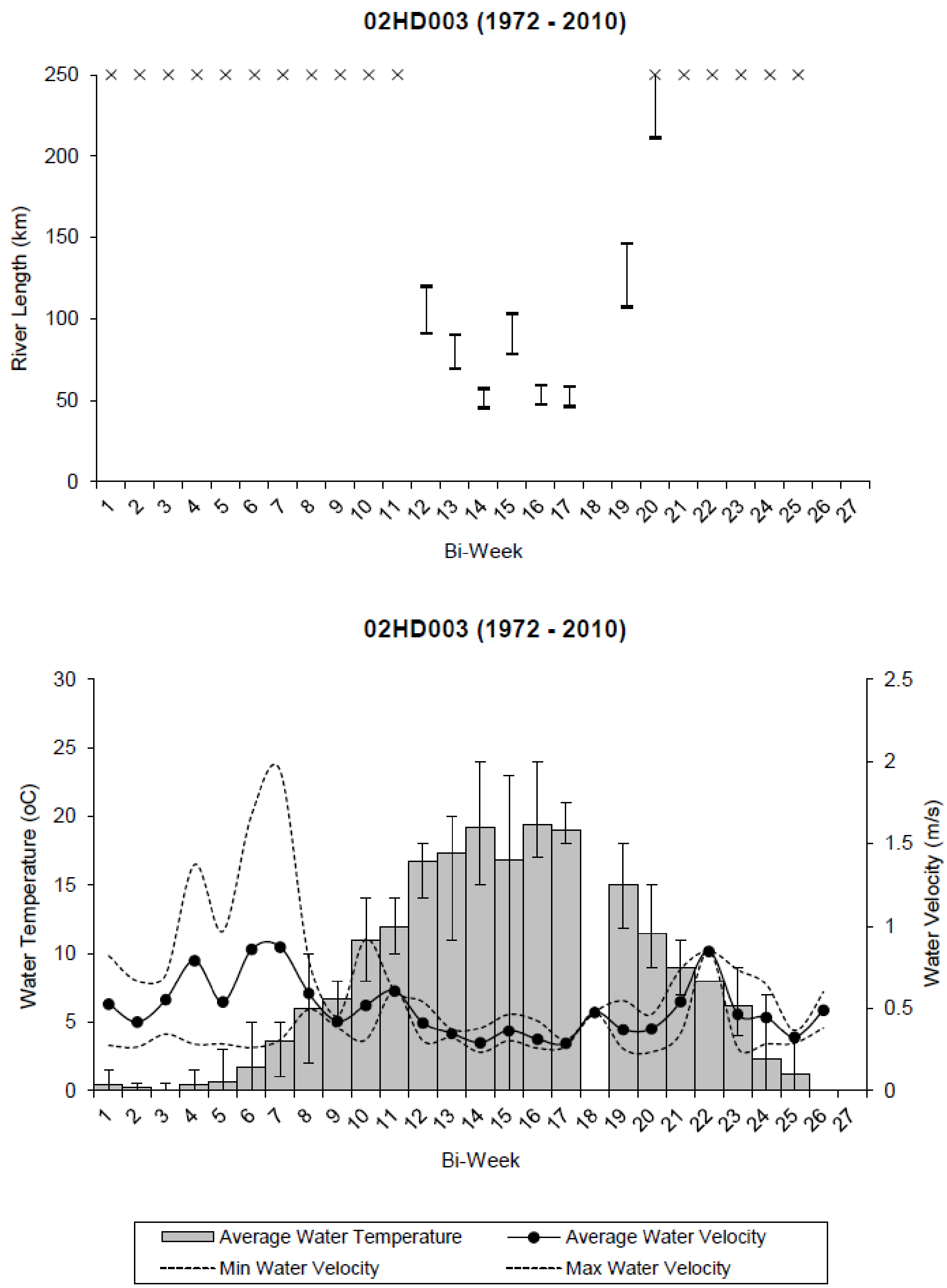
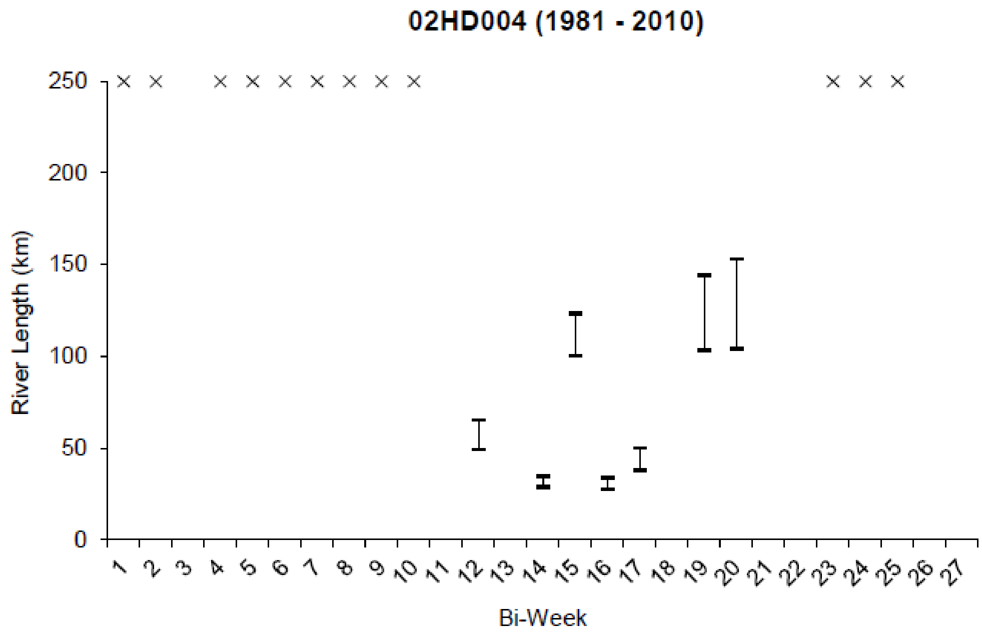


Figure A1-193. Gauging station 02HD003 data from 1972–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



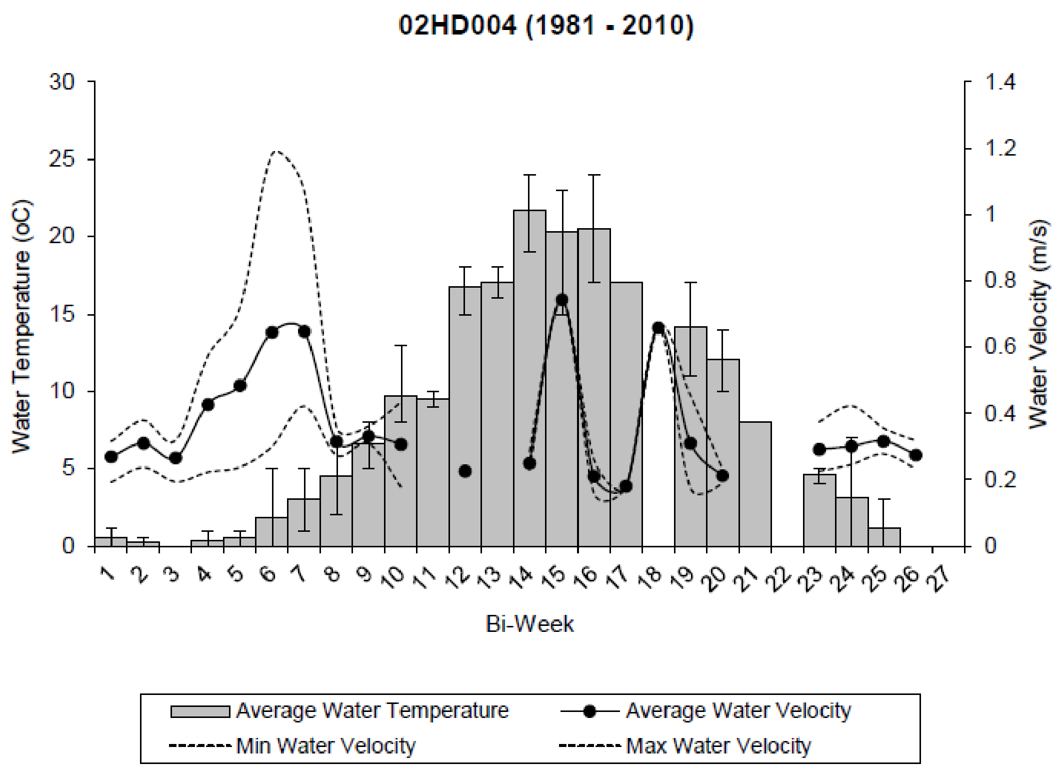
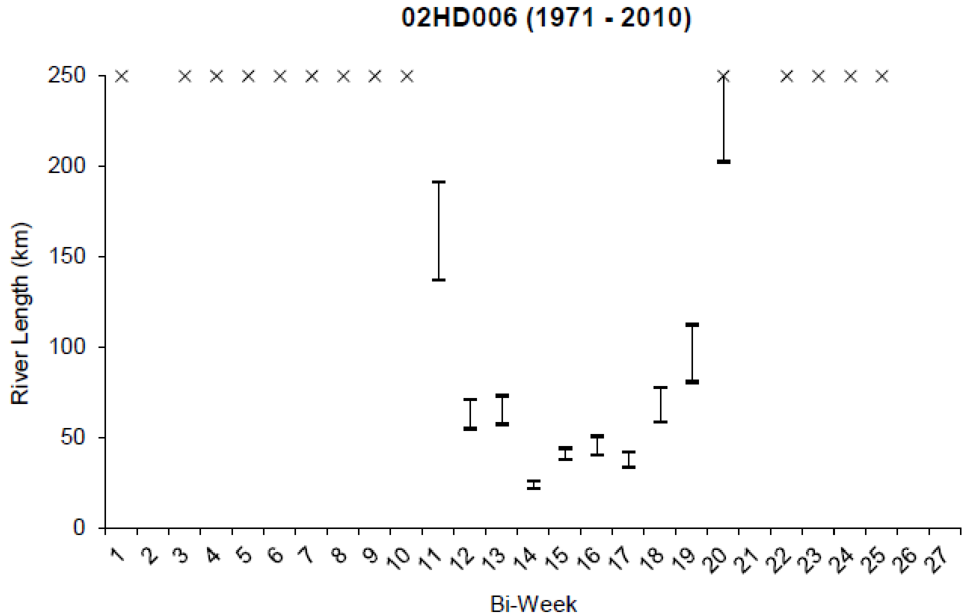


Figure A1-194. Gauging station 02HD004 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



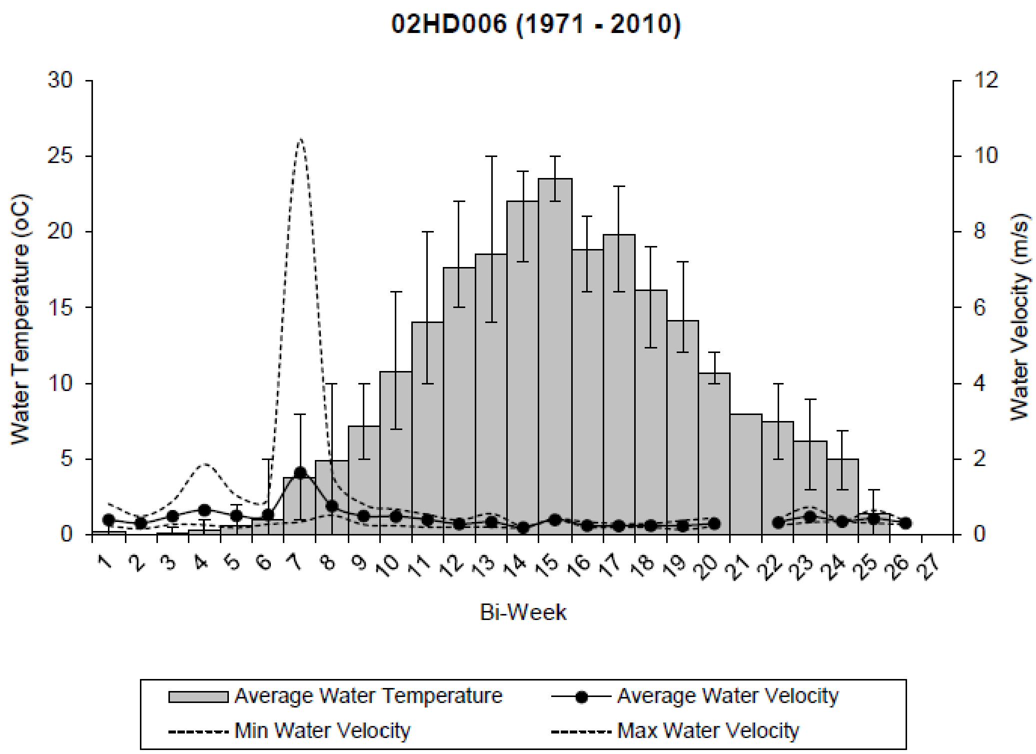


Figure A1-195. Gauging station 02HD006 data from 1971–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

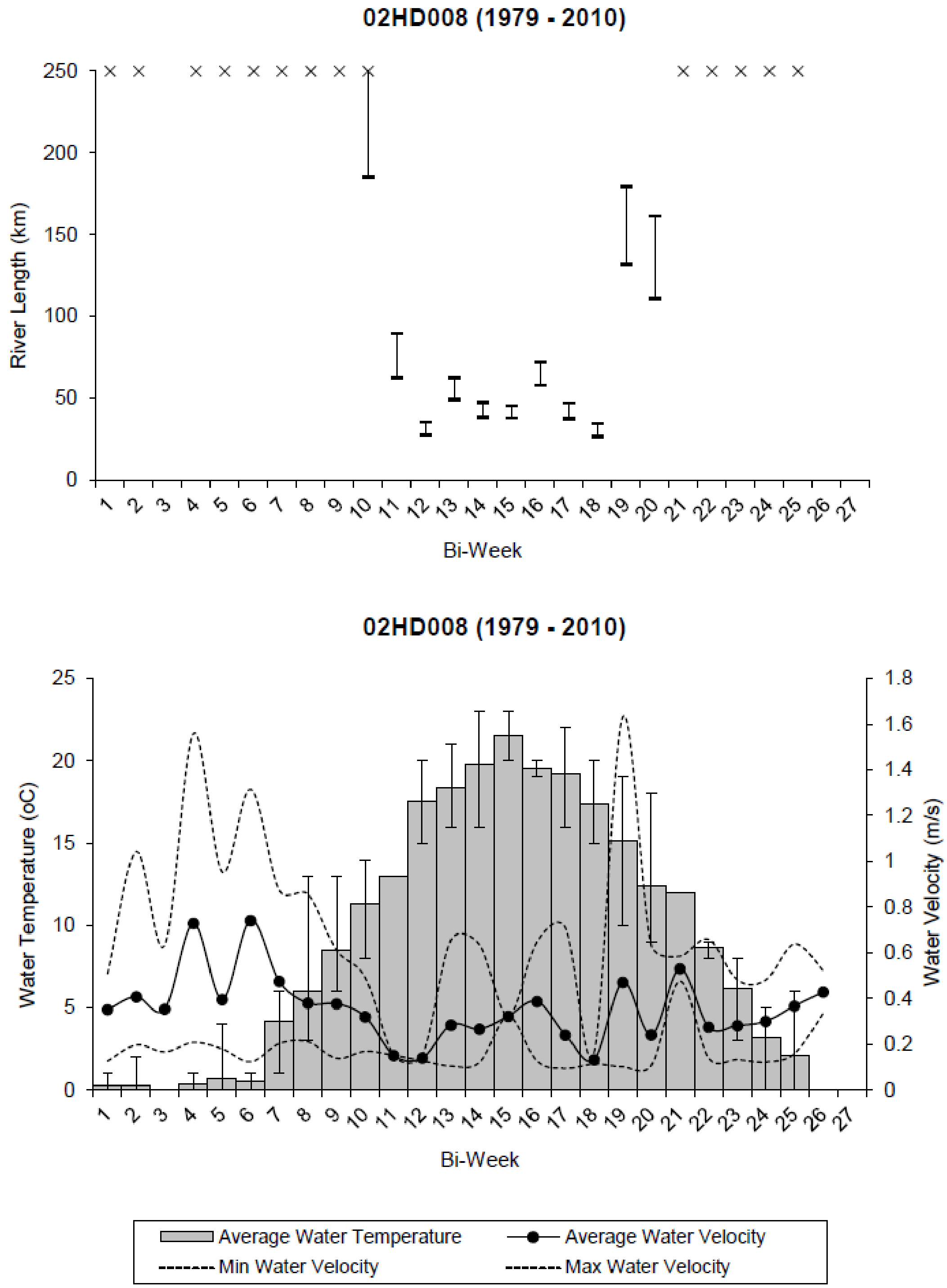
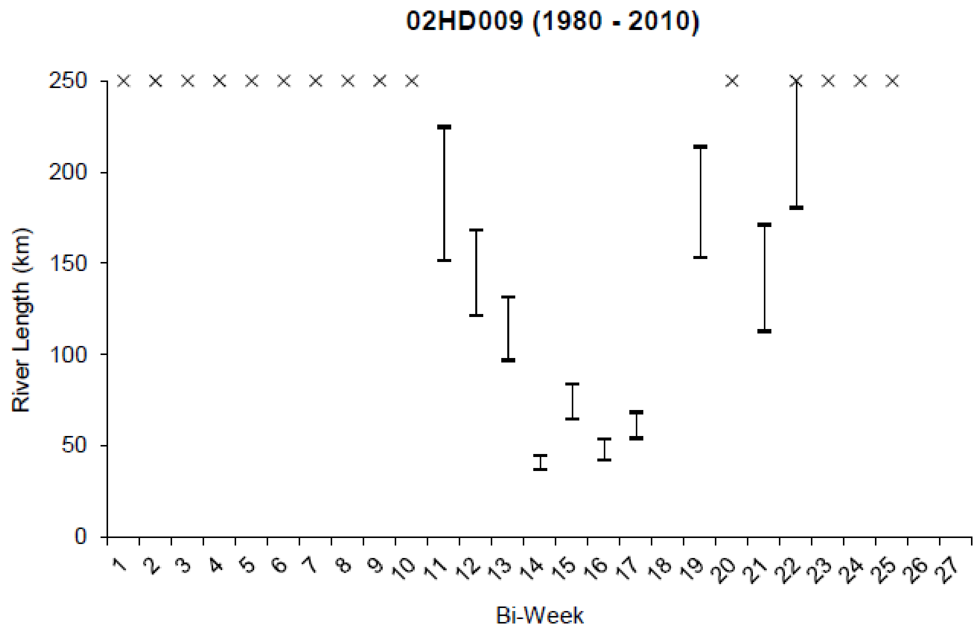


Figure A1-196. Gauging station 02HD008 data from 1979–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



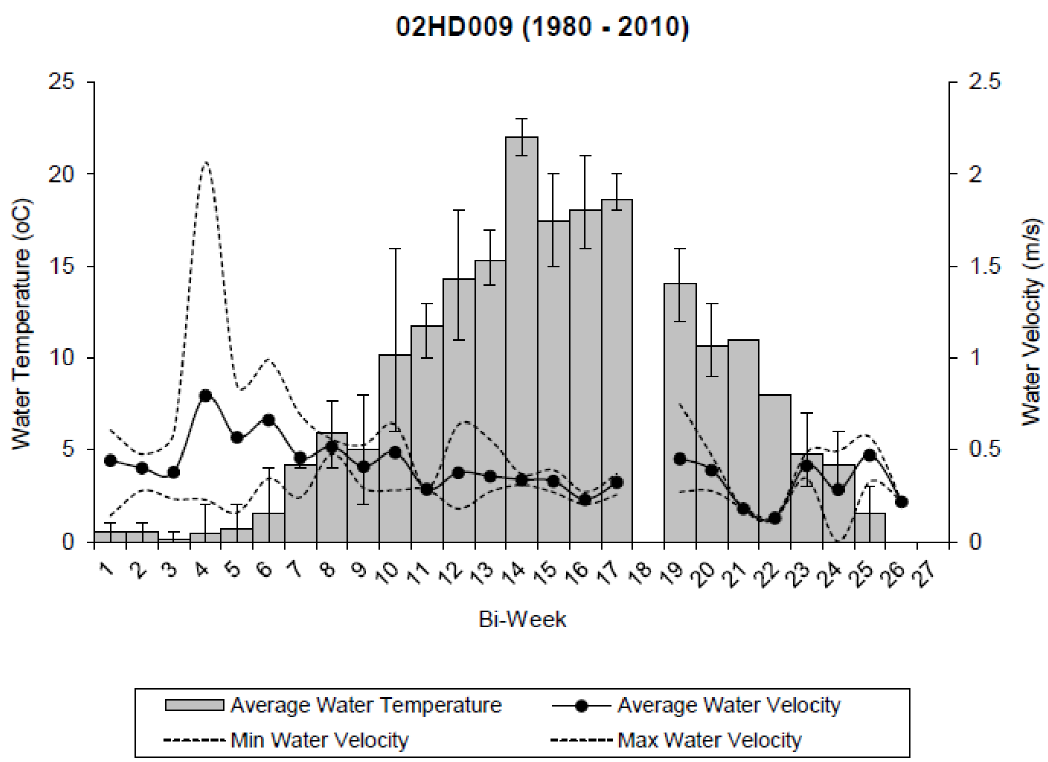
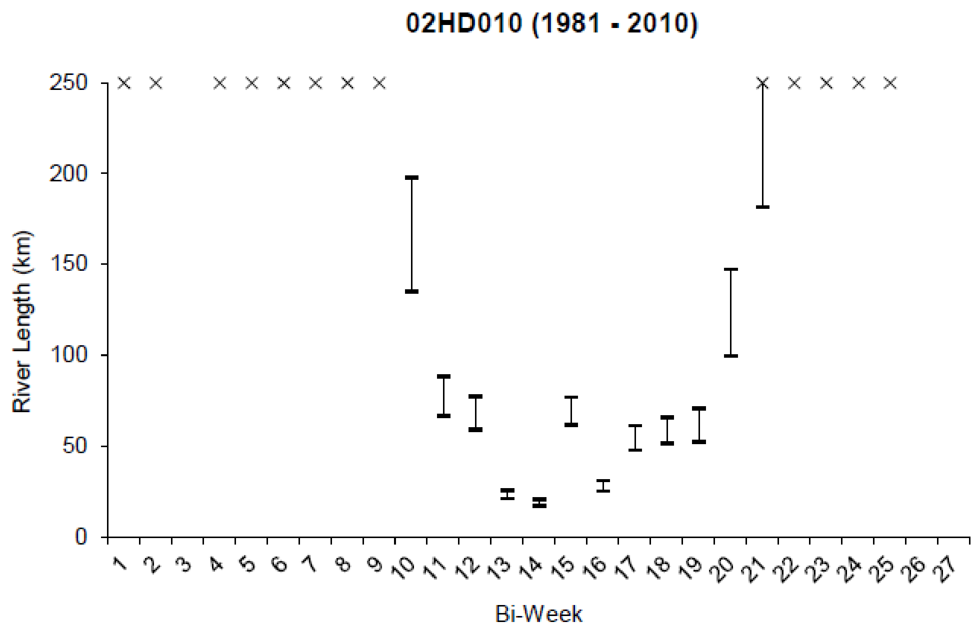


Figure A1-197. Gauging station 02HD009 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



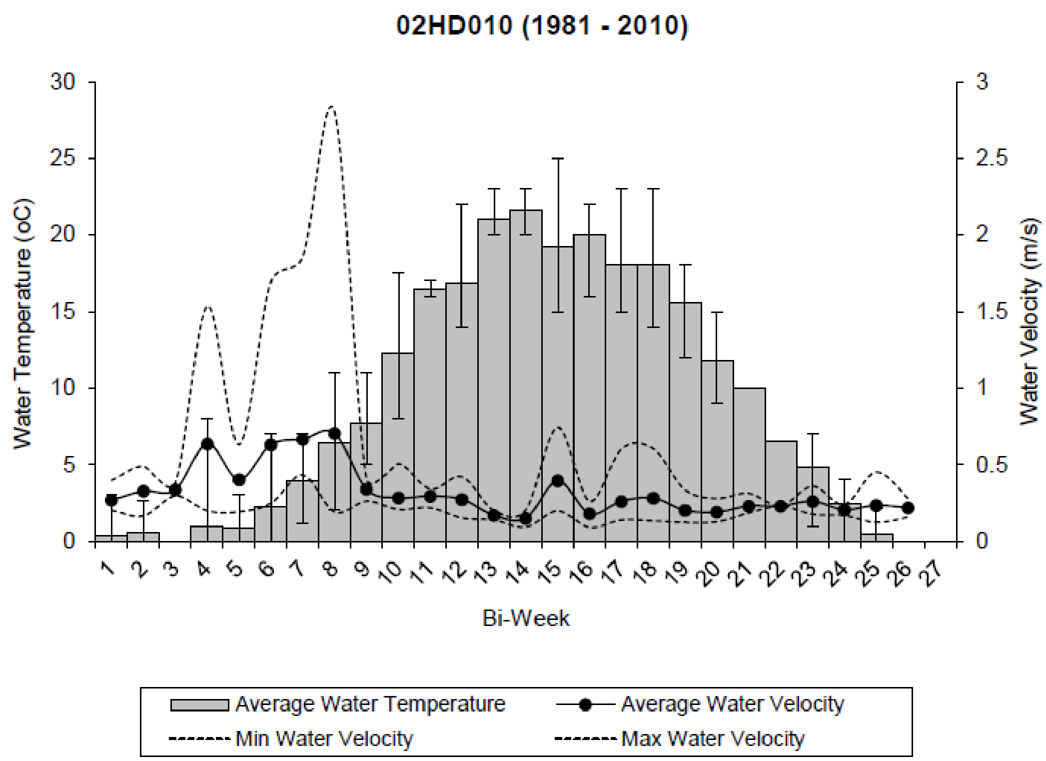


Figure A1-198. Gauging station 02HD010 data from 1981–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

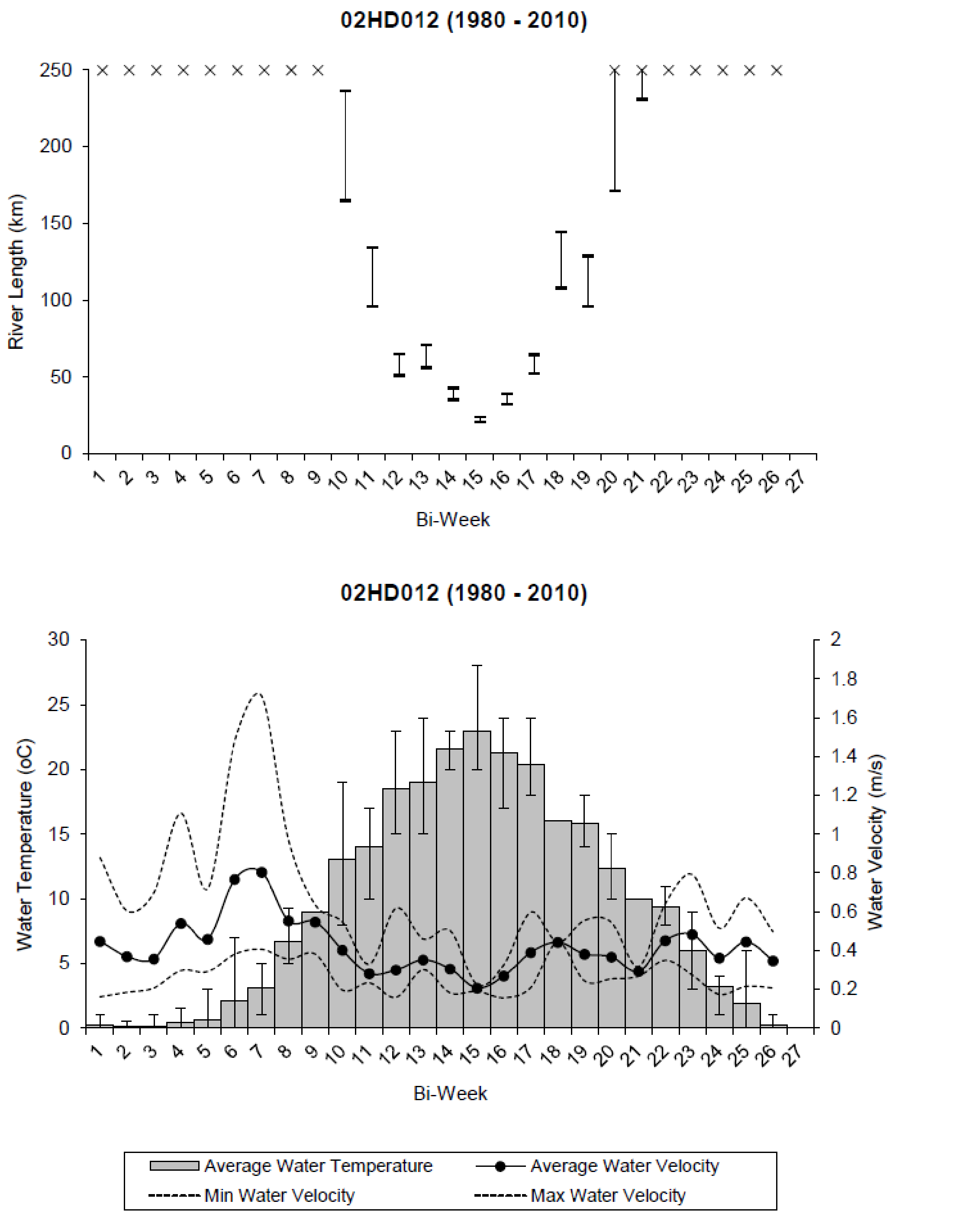
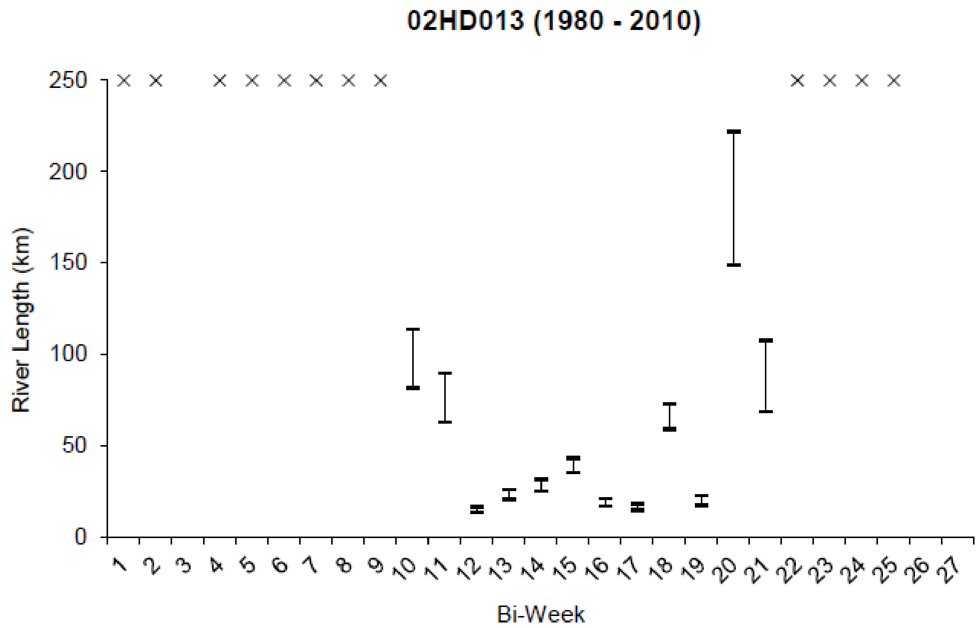


Figure A1-199. Gauging station 02HD012 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



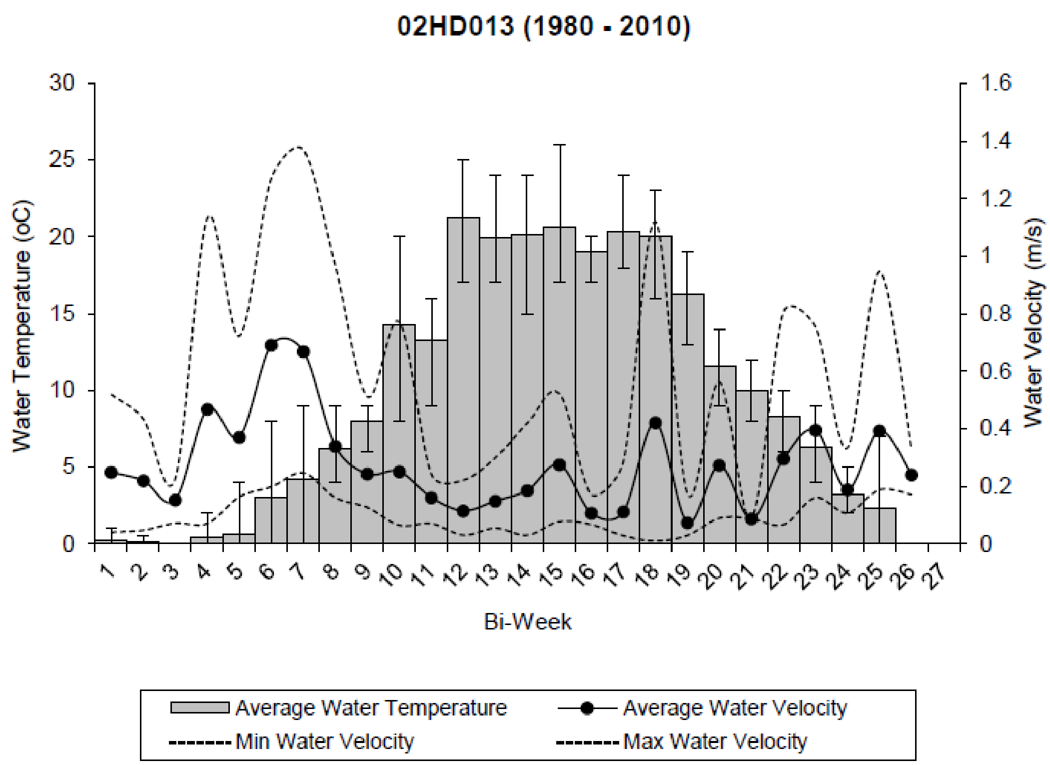
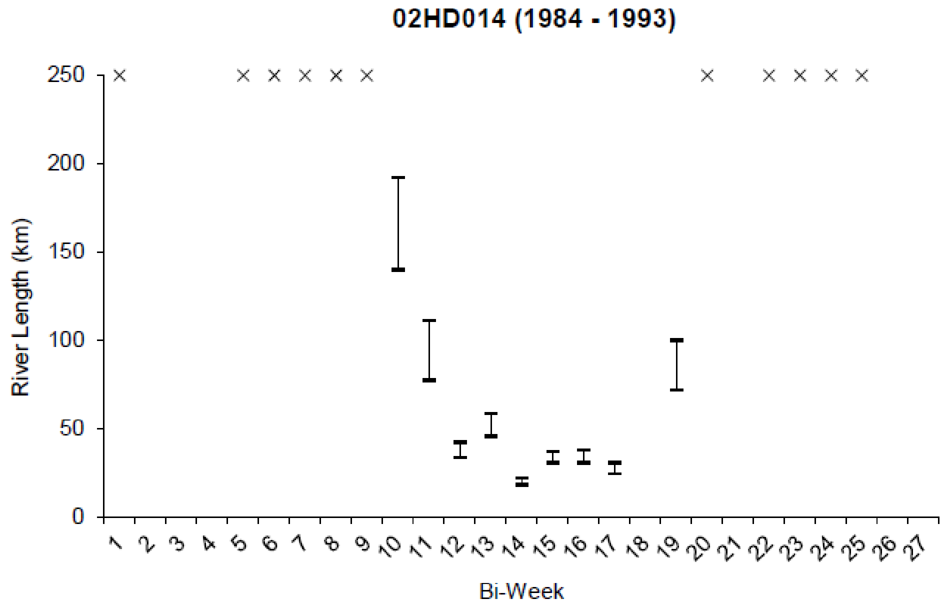


Figure A1-200. Gauging station 02HD013 data from 1980–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



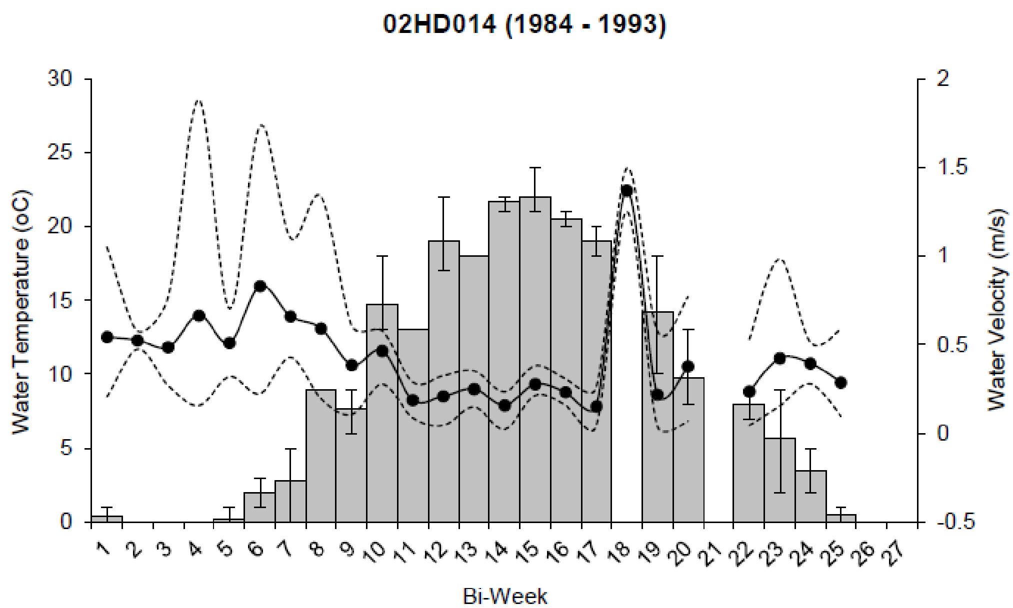
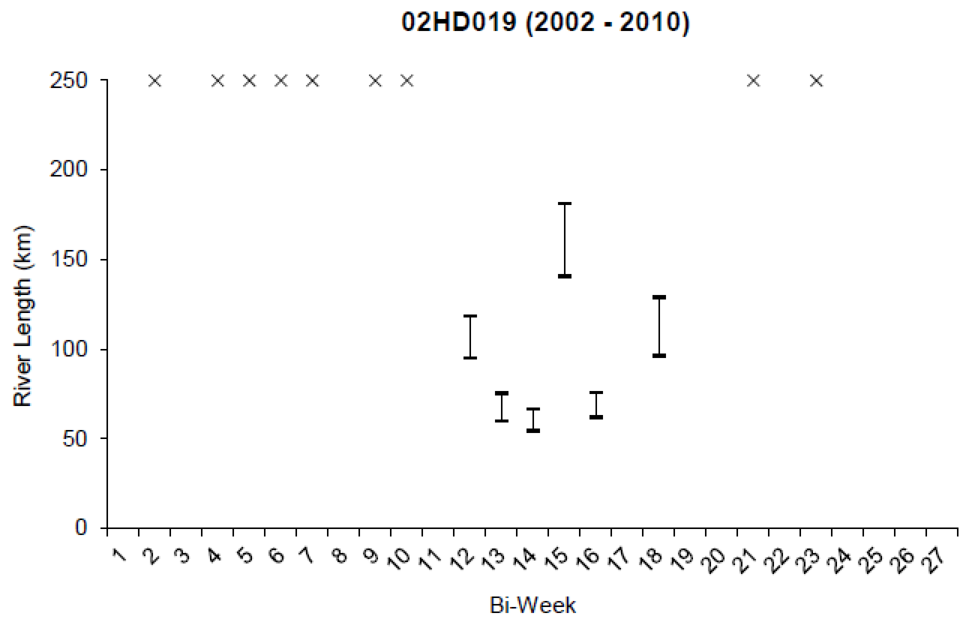


Figure A1-201. Gauging station 02HD014 data from 1984–1993 Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



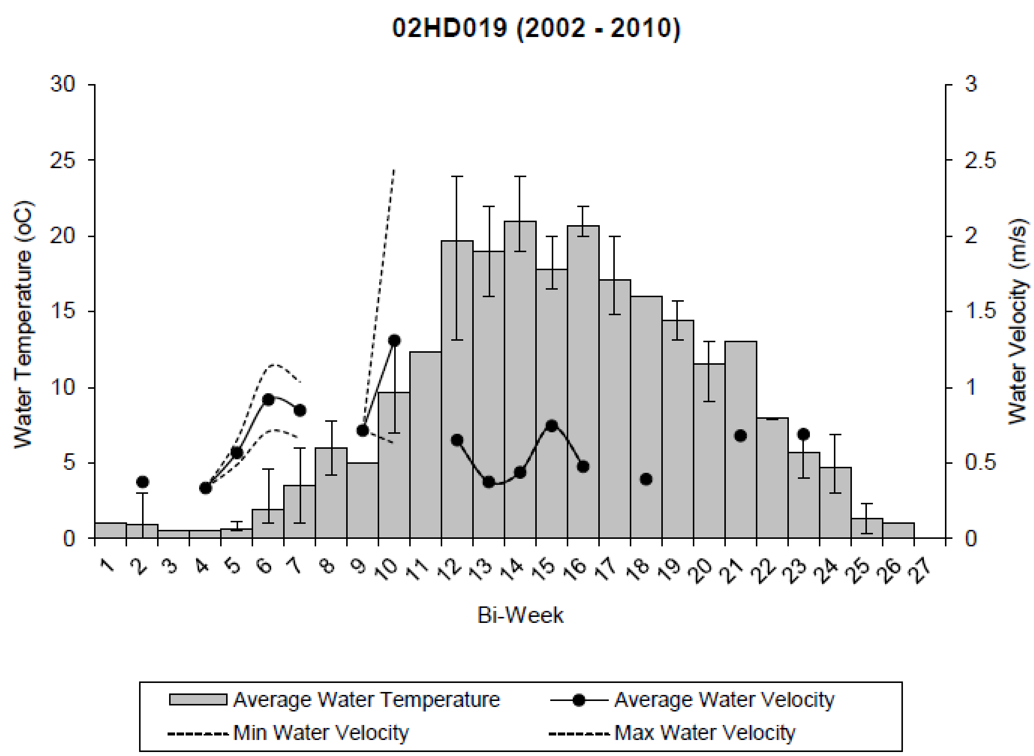
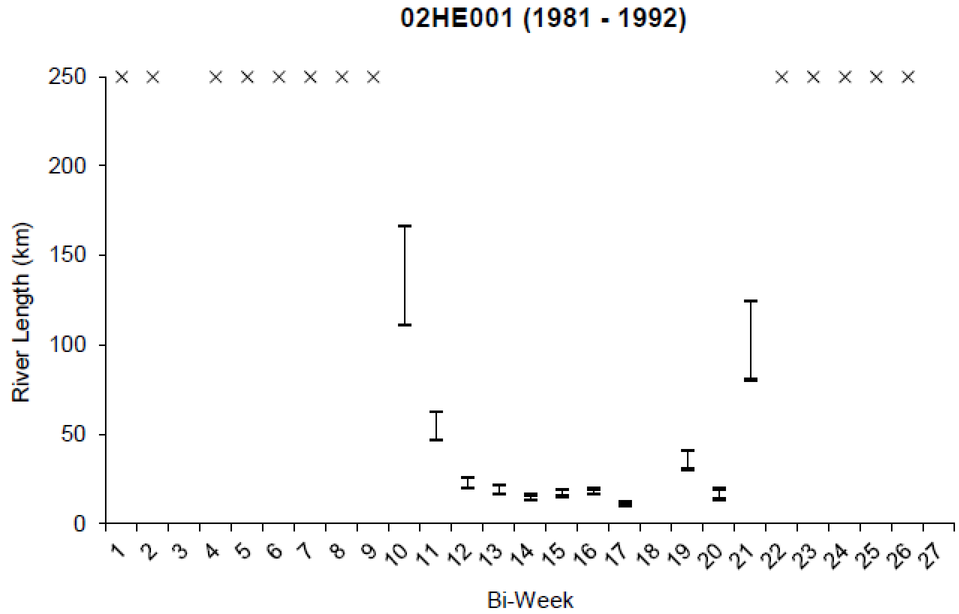


Figure A1-202. Gauging station 02HD019 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



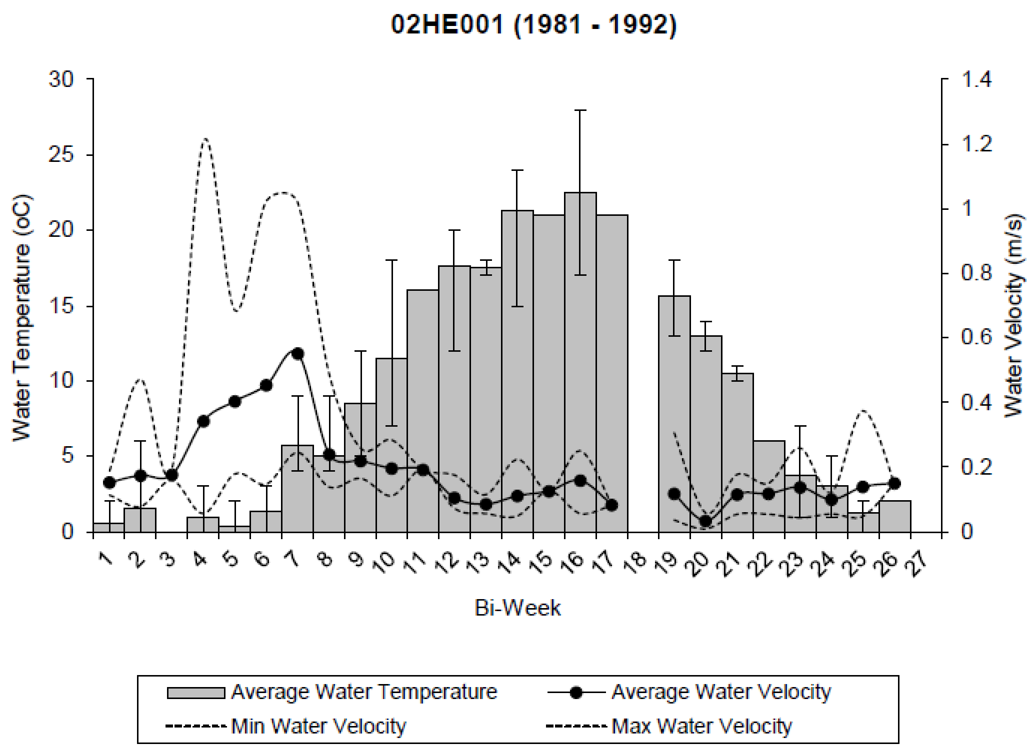
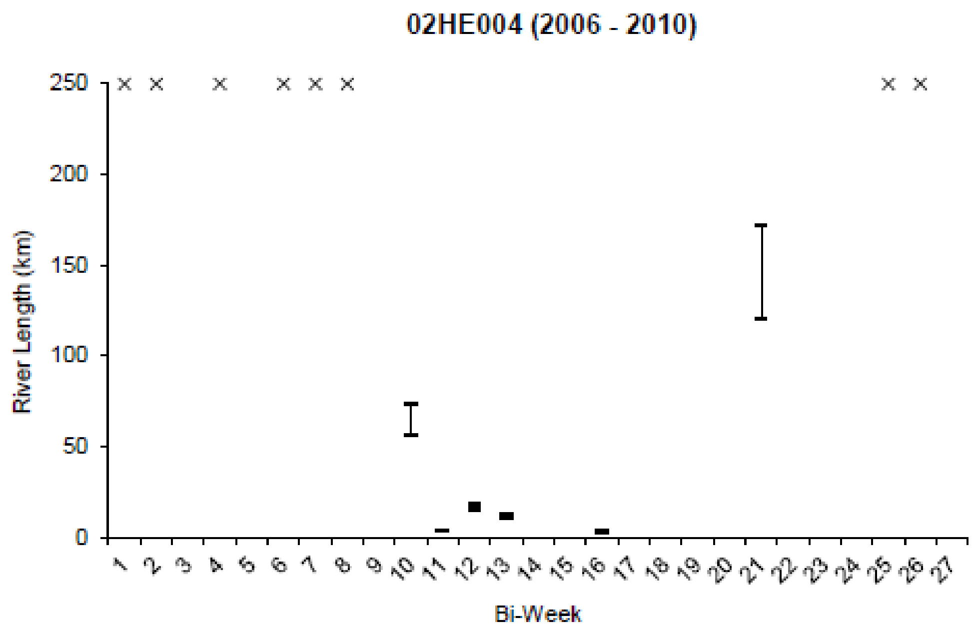


Figure A1-203. Gauging station 02HE001 data from 1981–1992. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



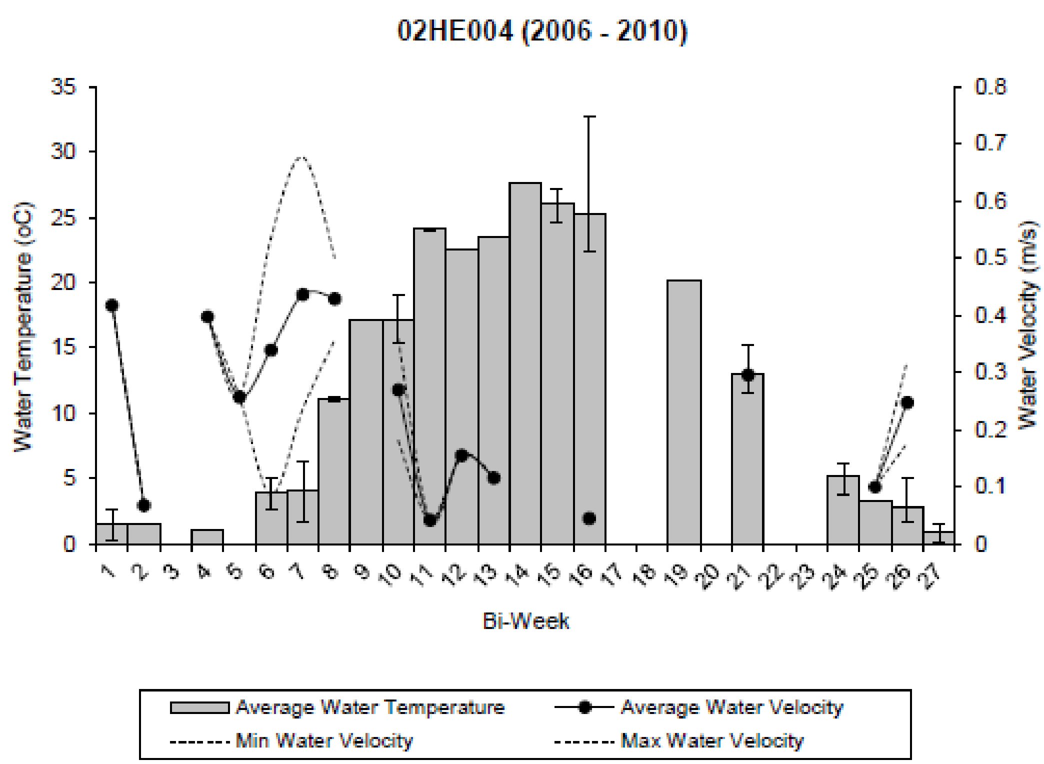
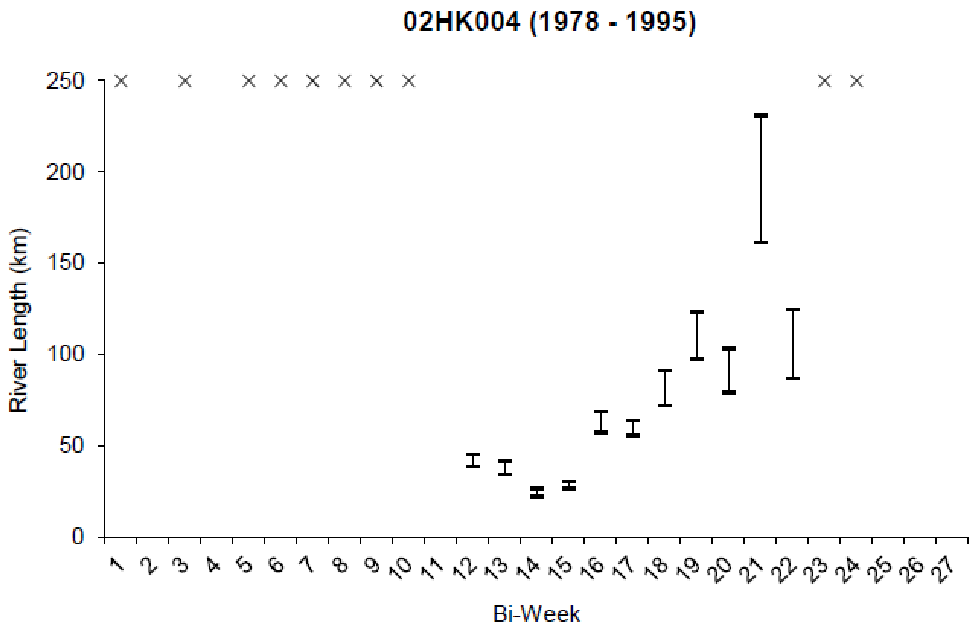


Figure A1-204. Gauging station 02HE004 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



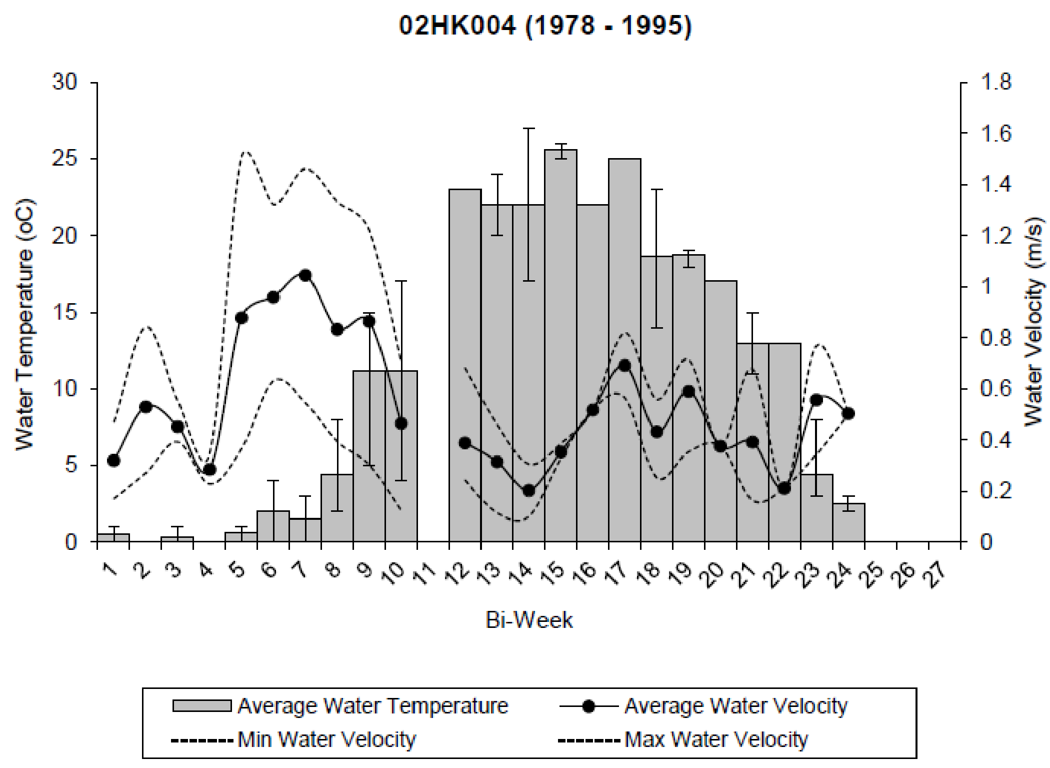


Figure A1-205. Gauging station 02HK004 data from 1978–1995. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

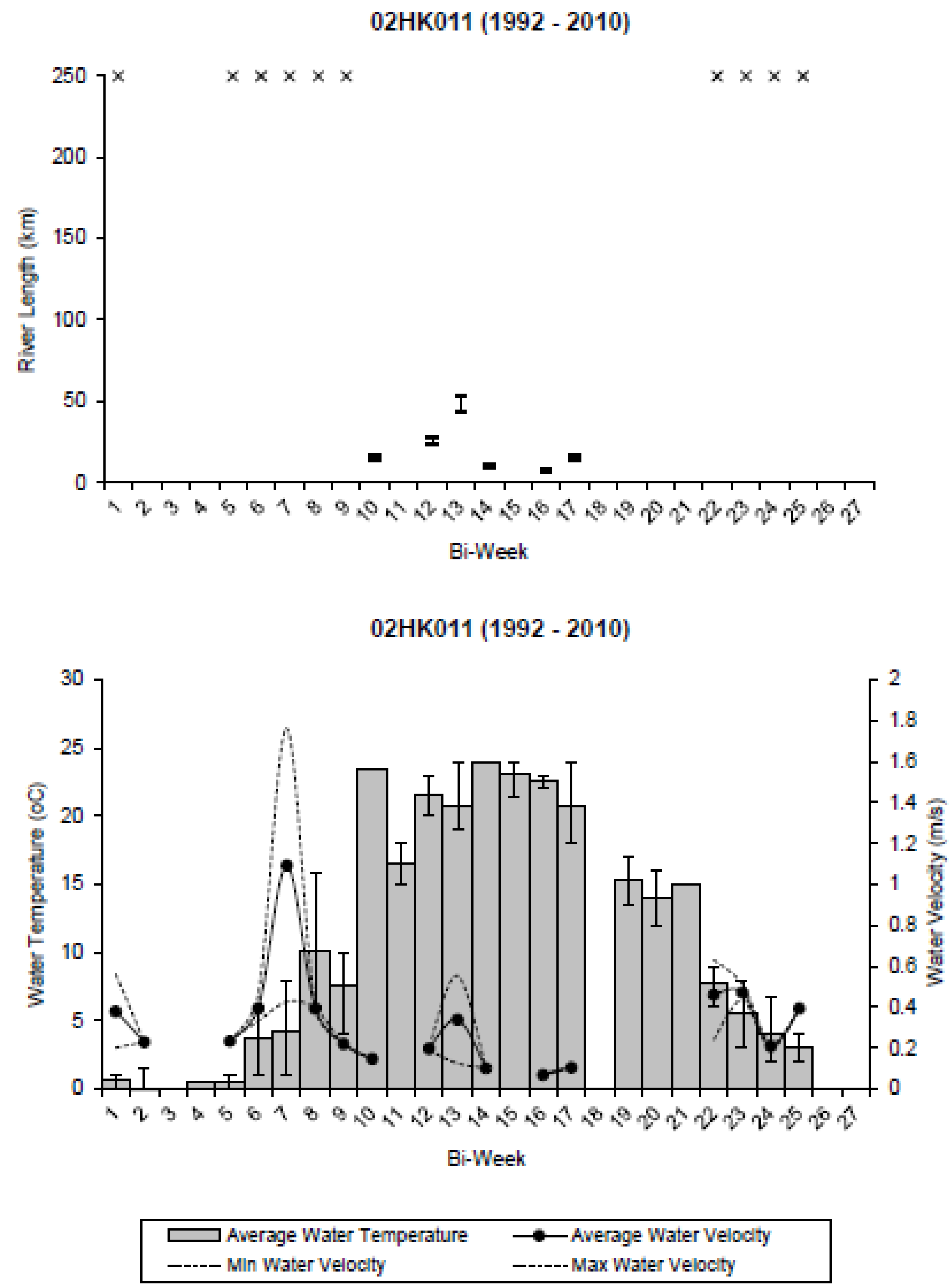
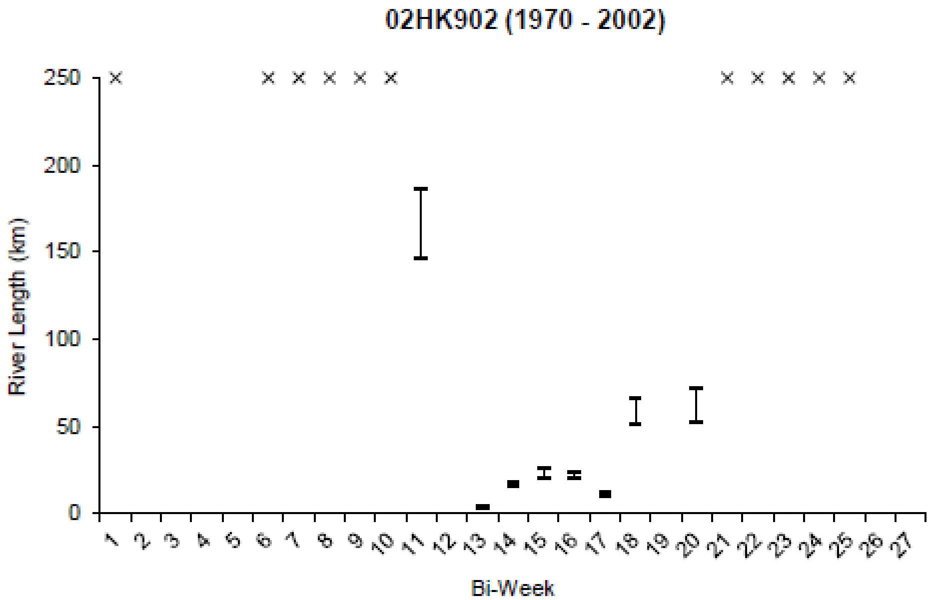


Figure A1-206. Gauging station 02HK011 data from 1992–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



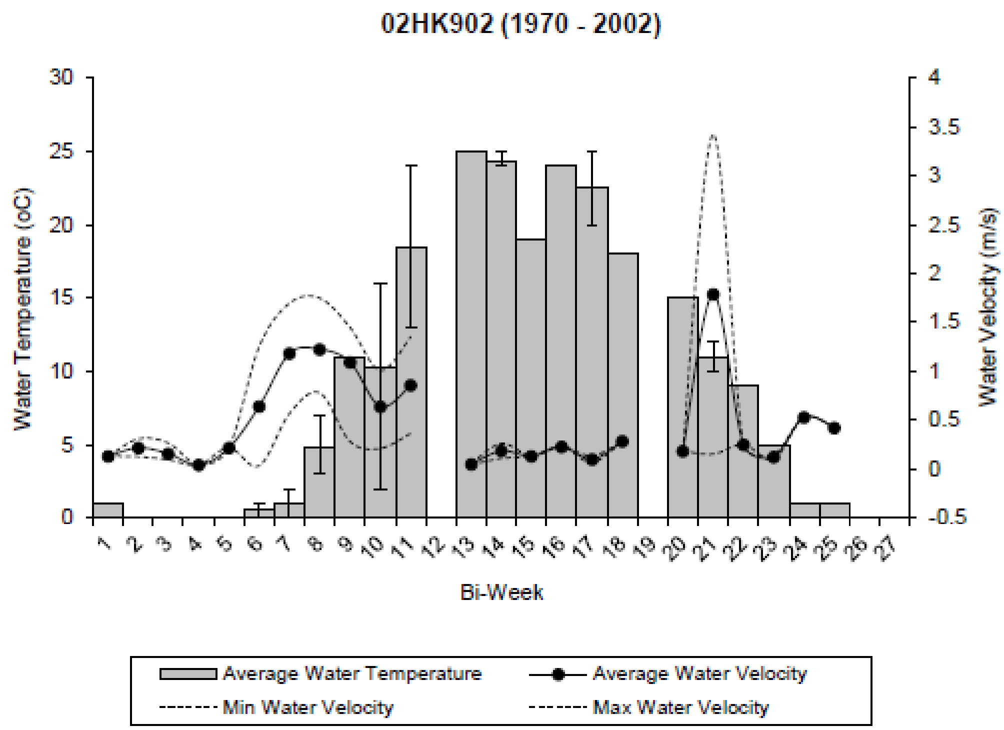
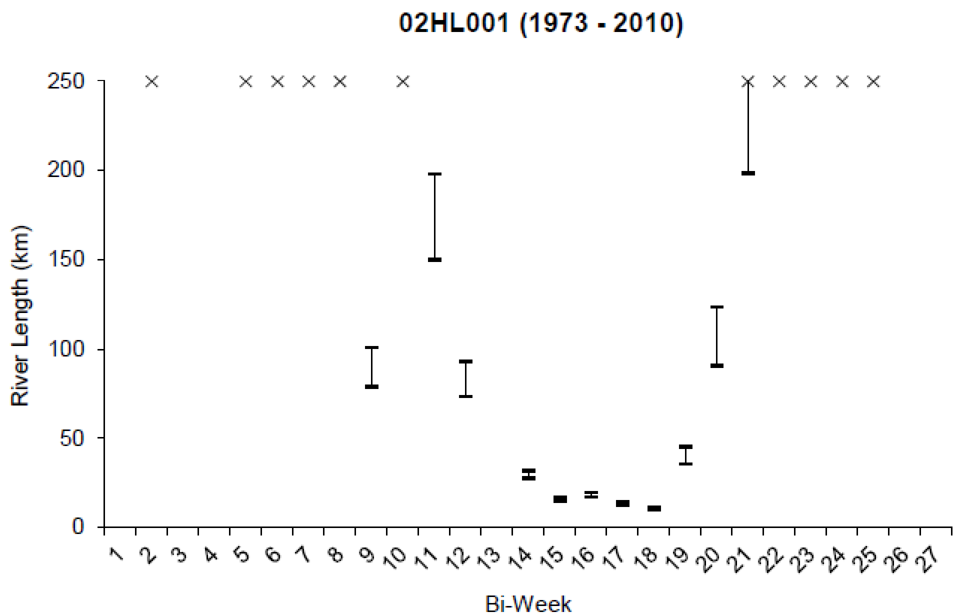


Figure A1-207. Gauging station 02HK902 data from 1970–2002. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



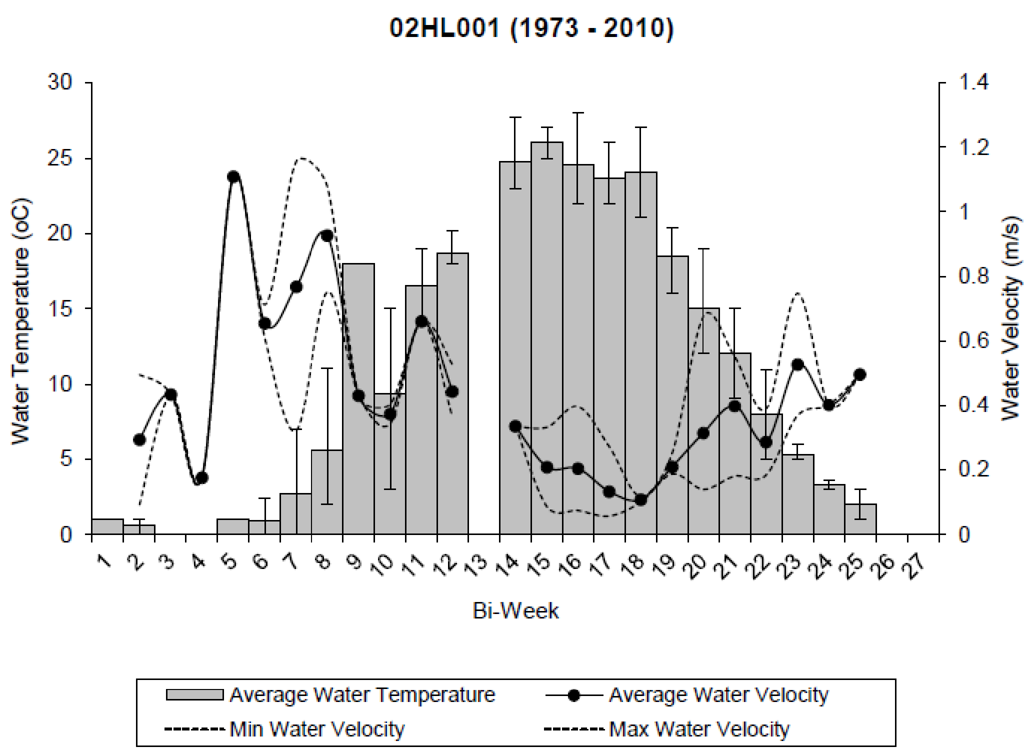


Figure A1-208. Gauging station 02HL001 data from 1973–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

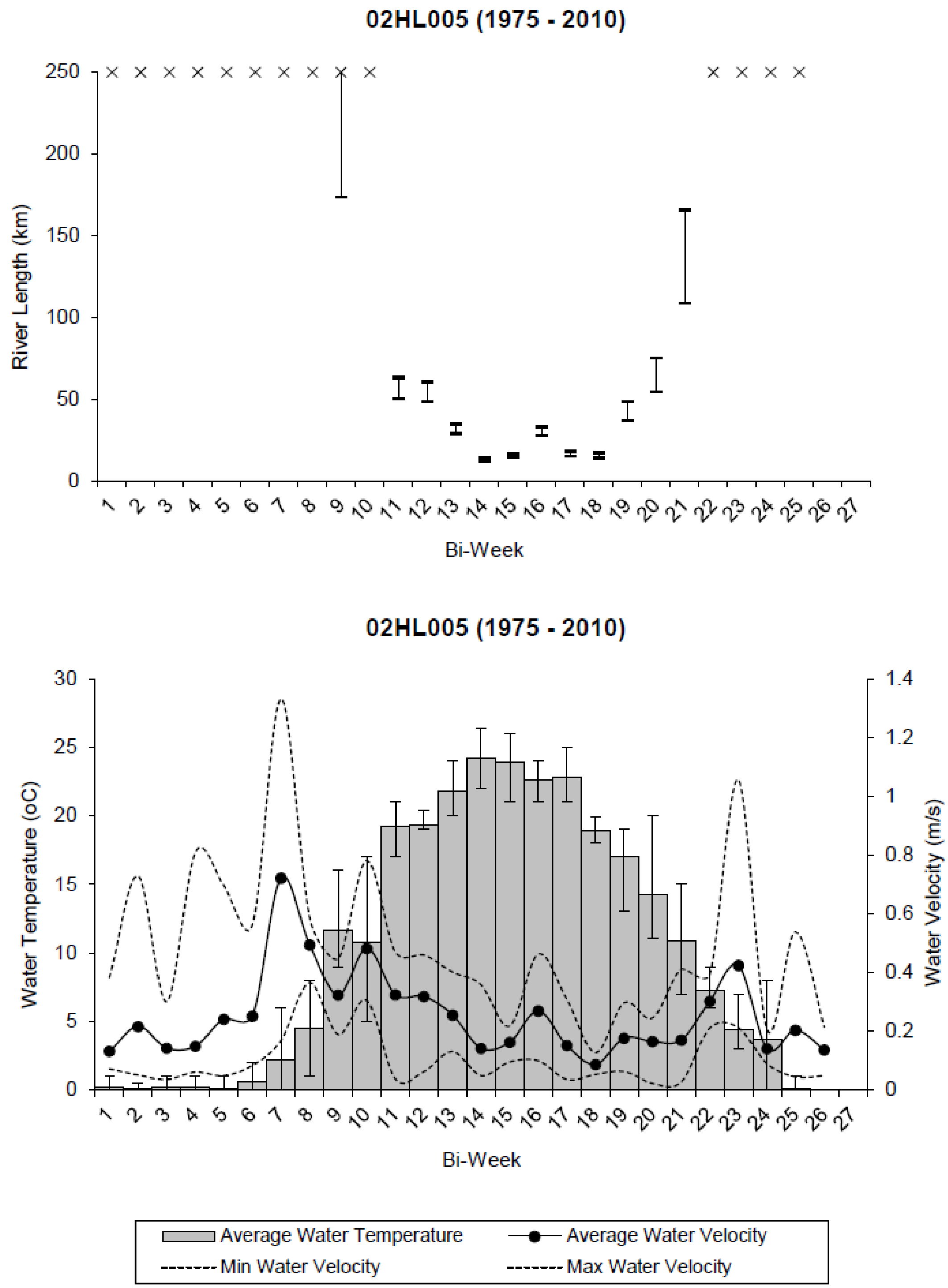
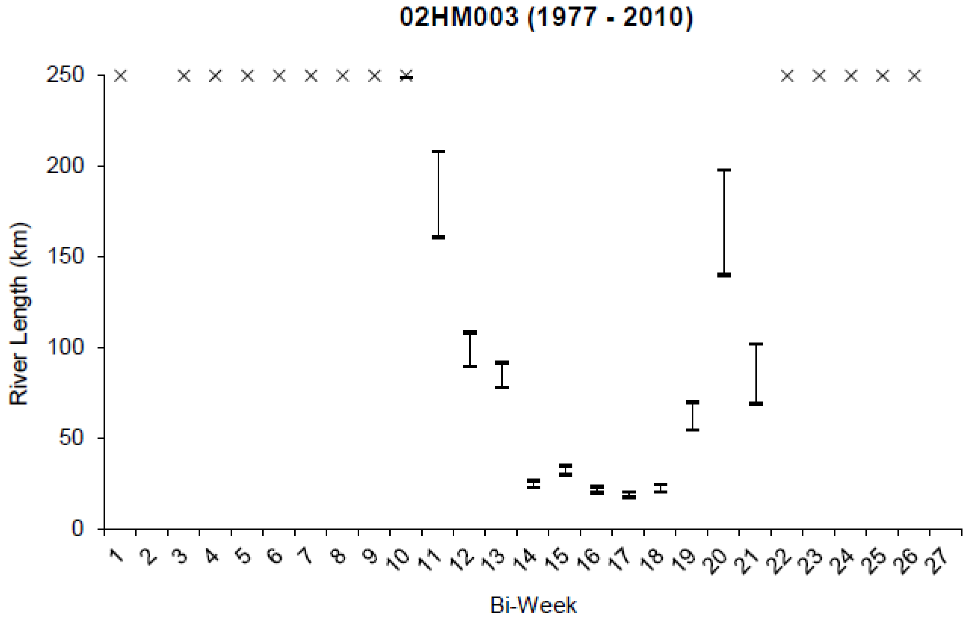


Figure A1-209. Gauging station 02HL005 data from 1975–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



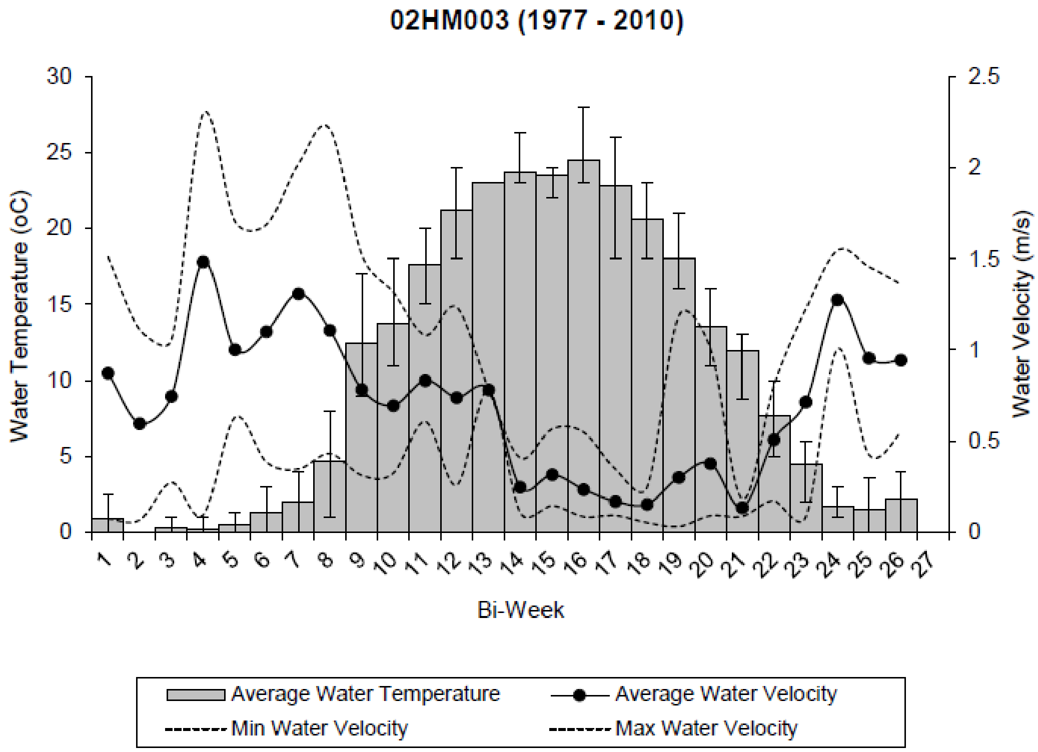
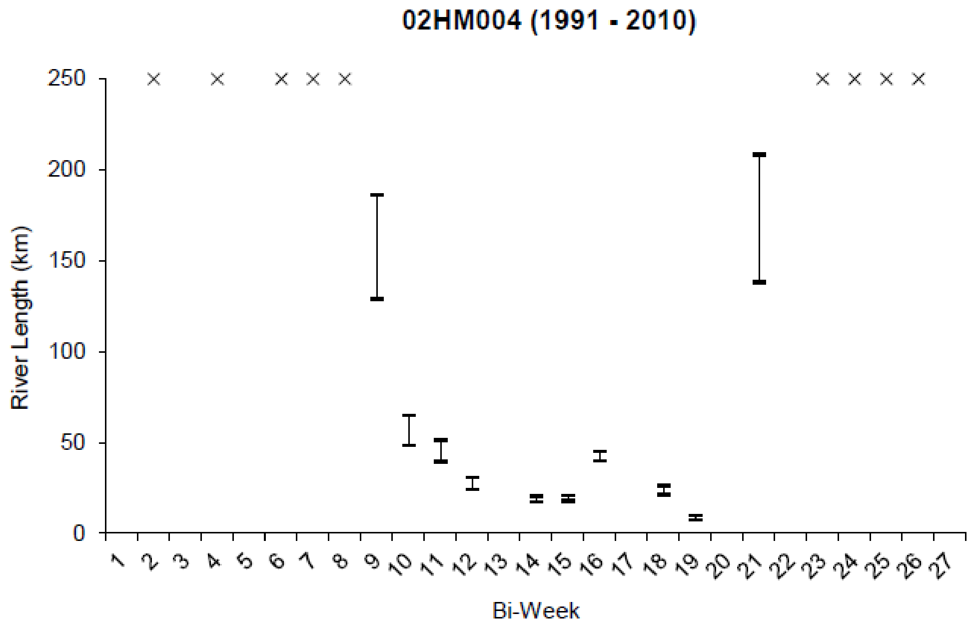


Figure A1-210. Gauging station 02HM003 data from 1977–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



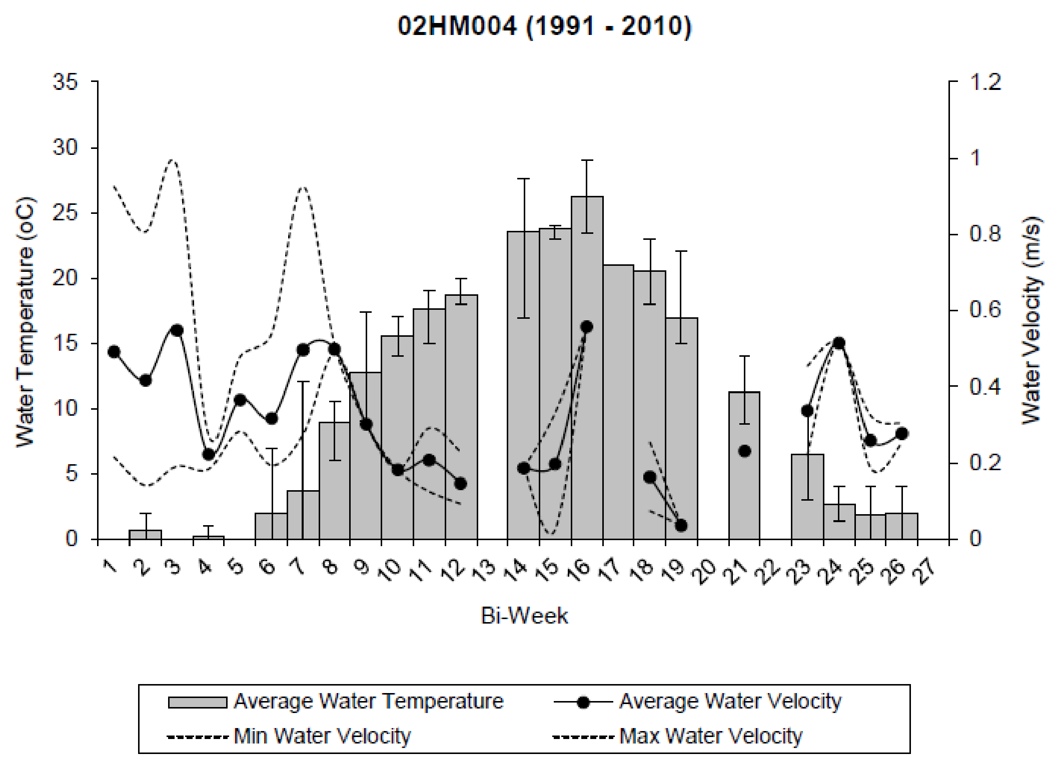


Figure A1-211. Gauging station 02HM004 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

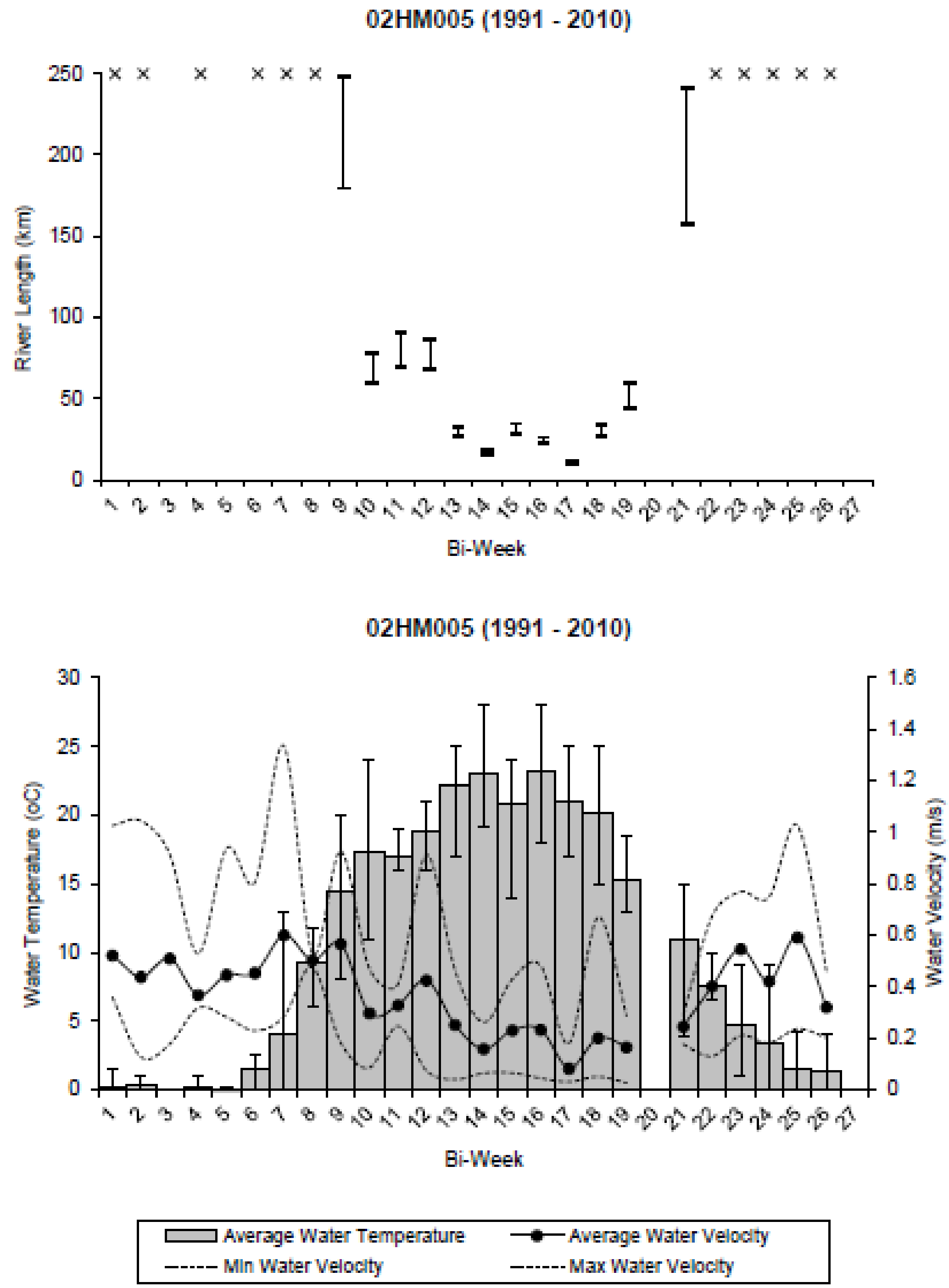
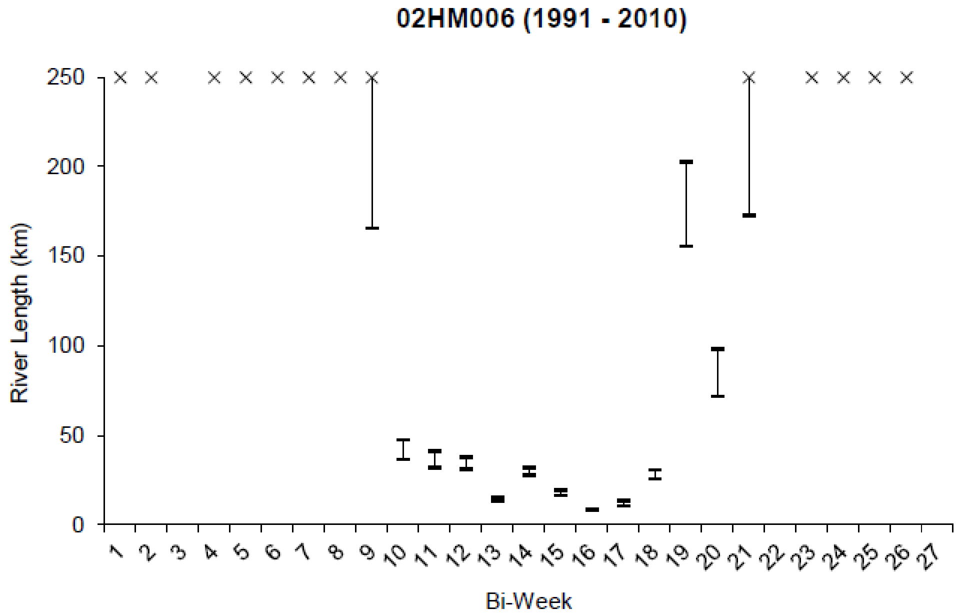


Figure A1-212. Gauging station 02HM005 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



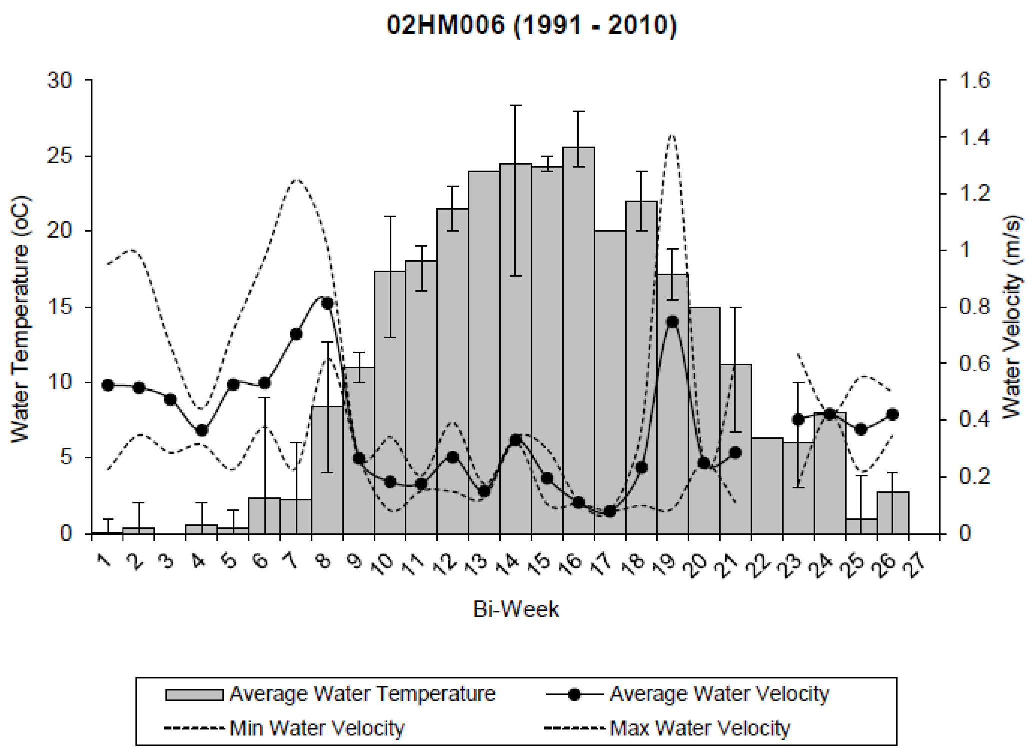
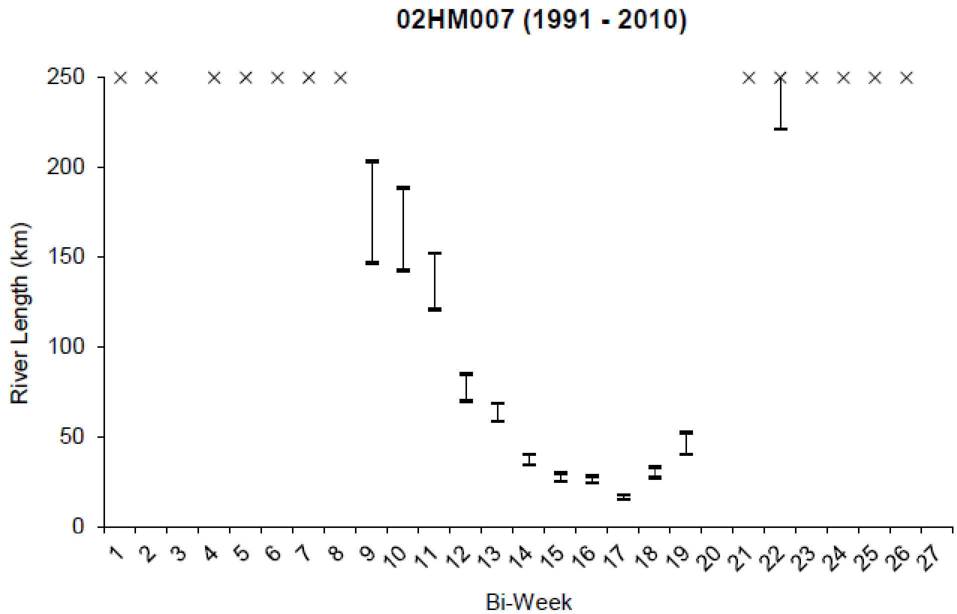


Figure A1-213. Gauging station 02HM006 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



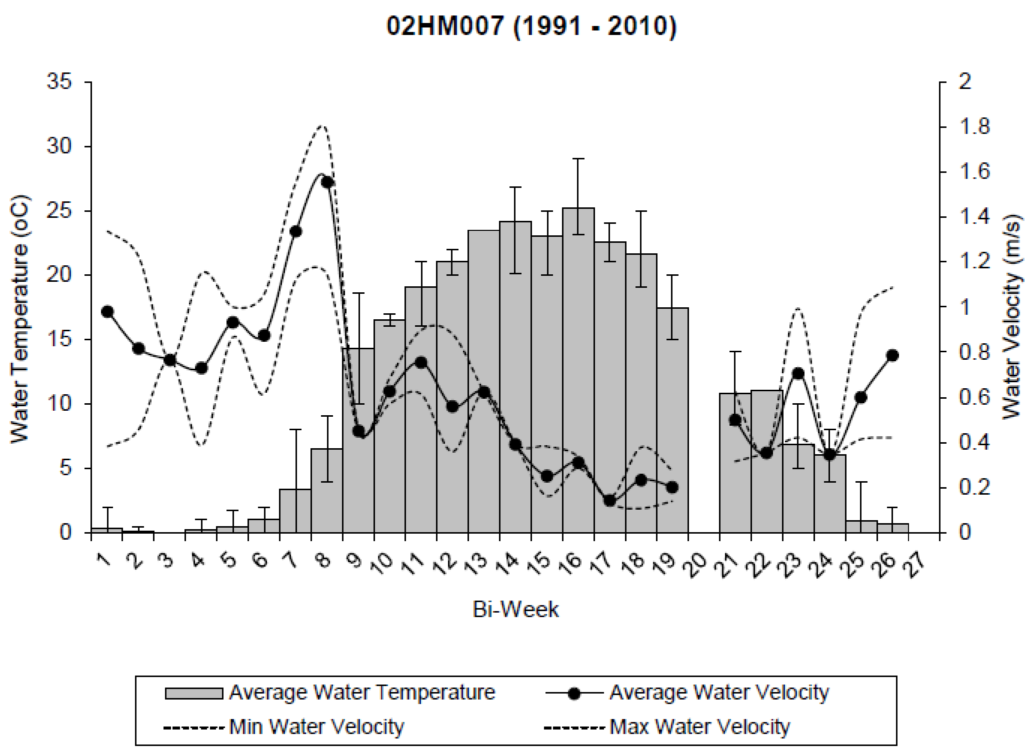
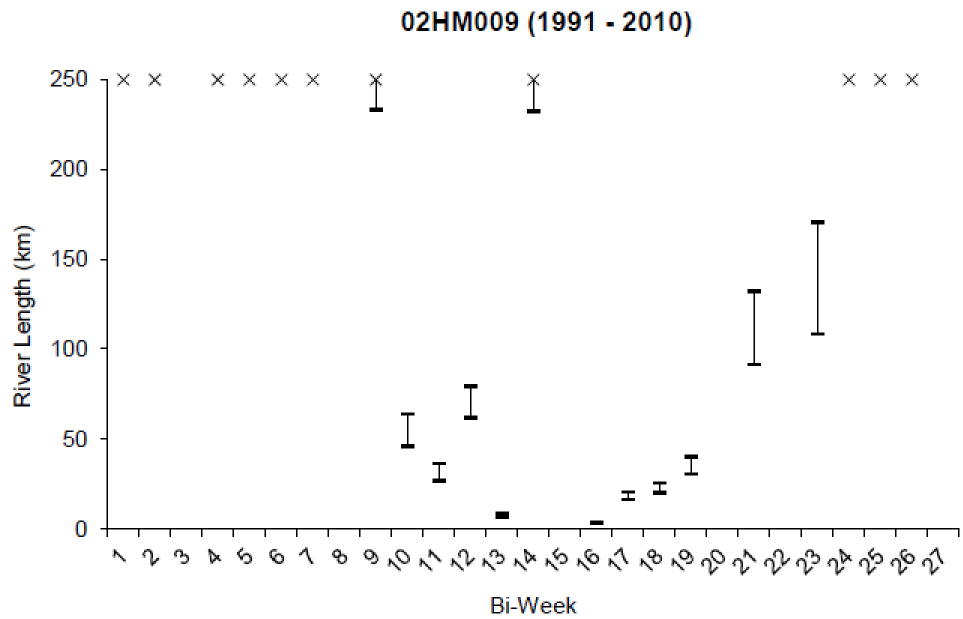


Figure A1-214. Gauging station 02HM007 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



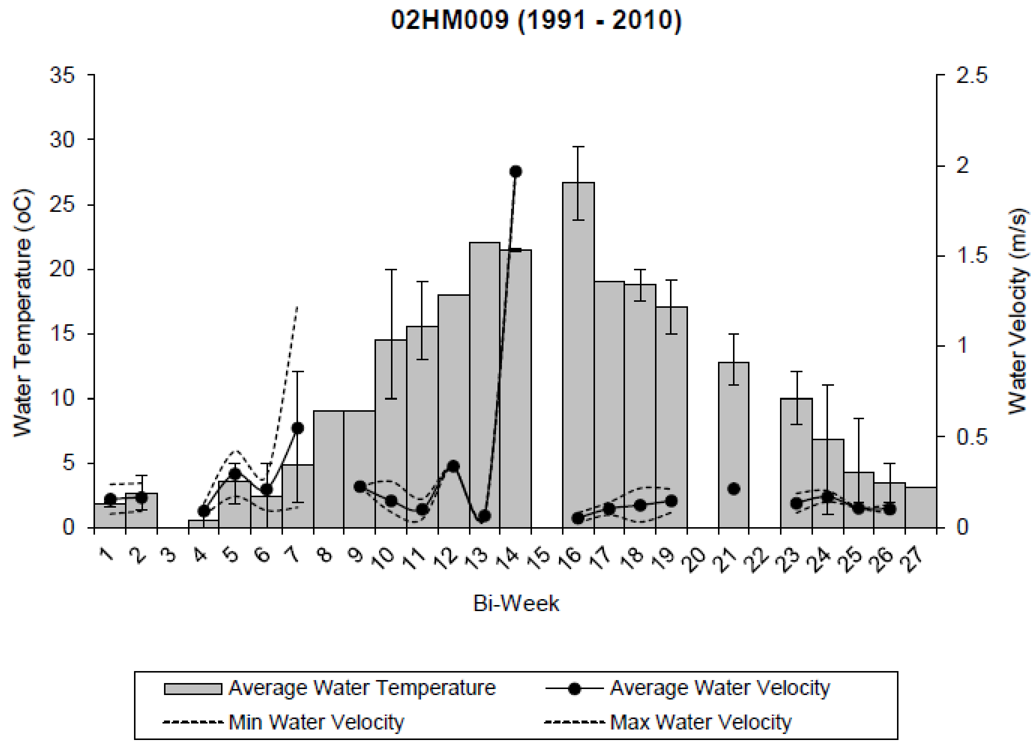


Figure A1-215. Gauging station 02HM009 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.

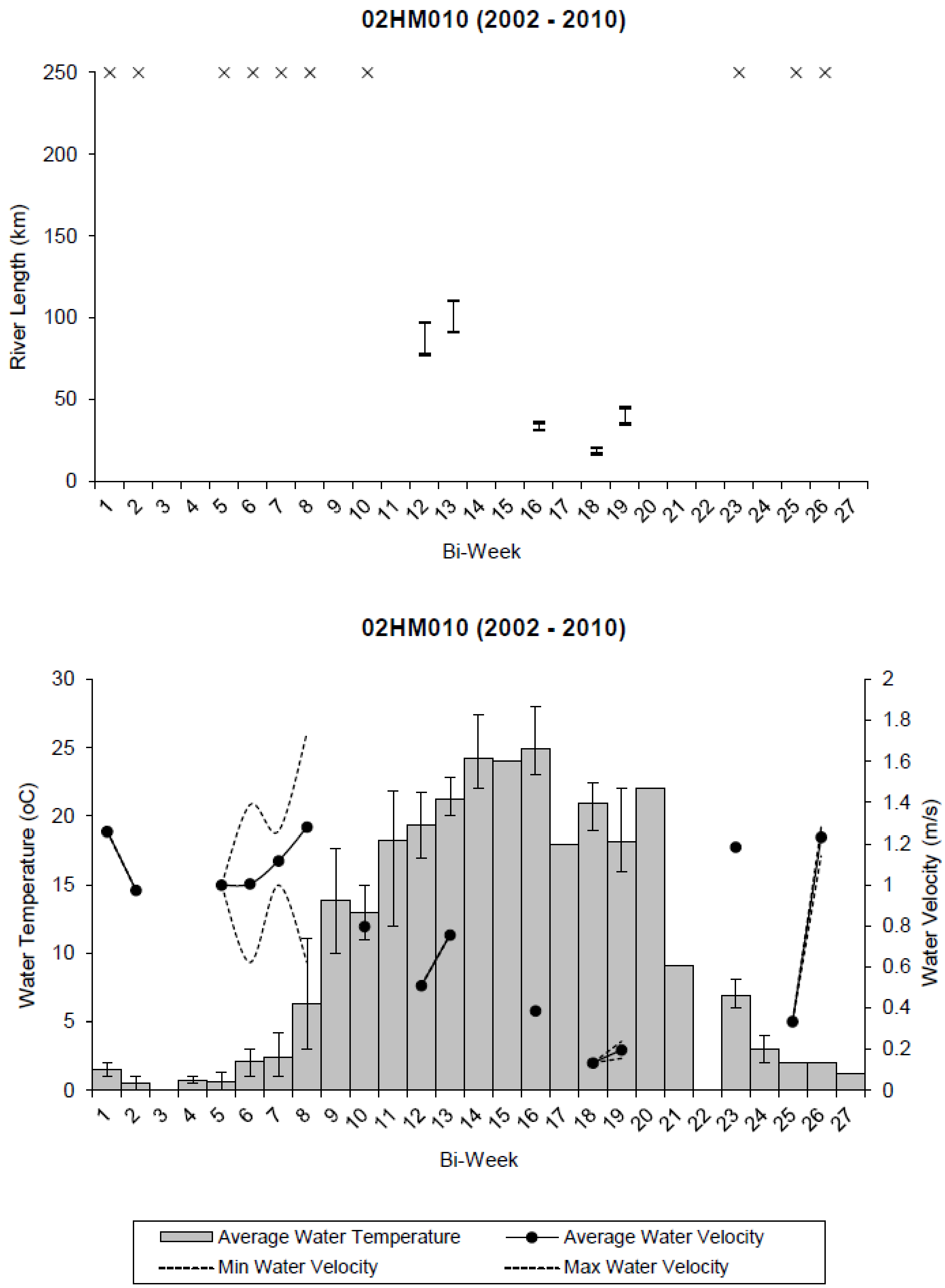
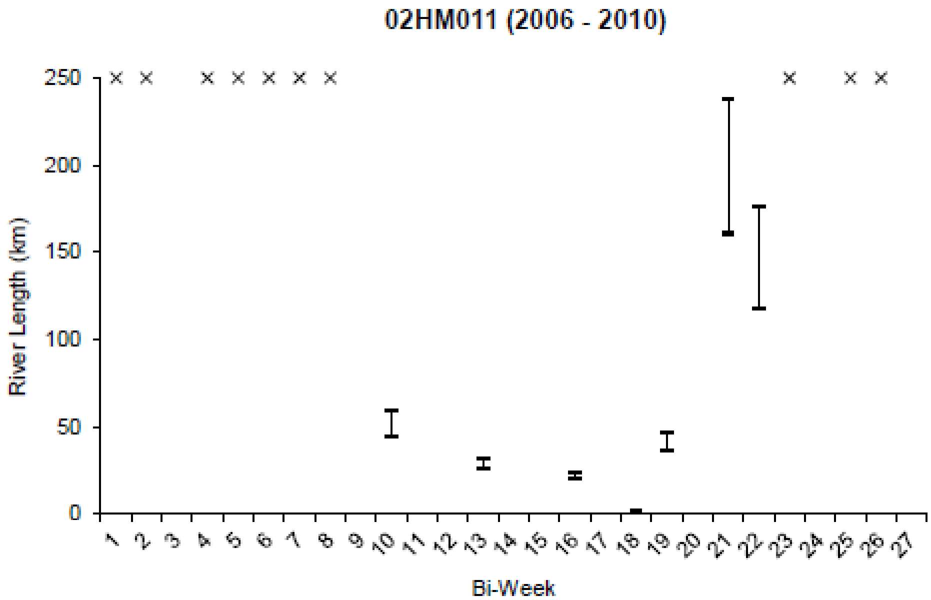


Figure A1-216. Gauging station 02HM010 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



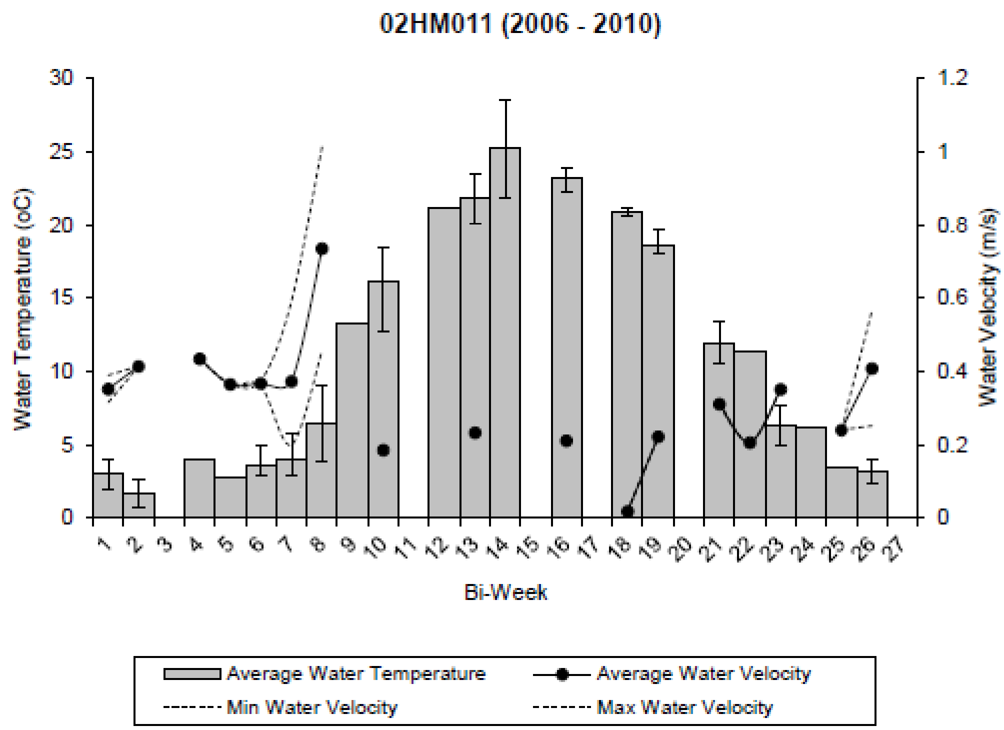
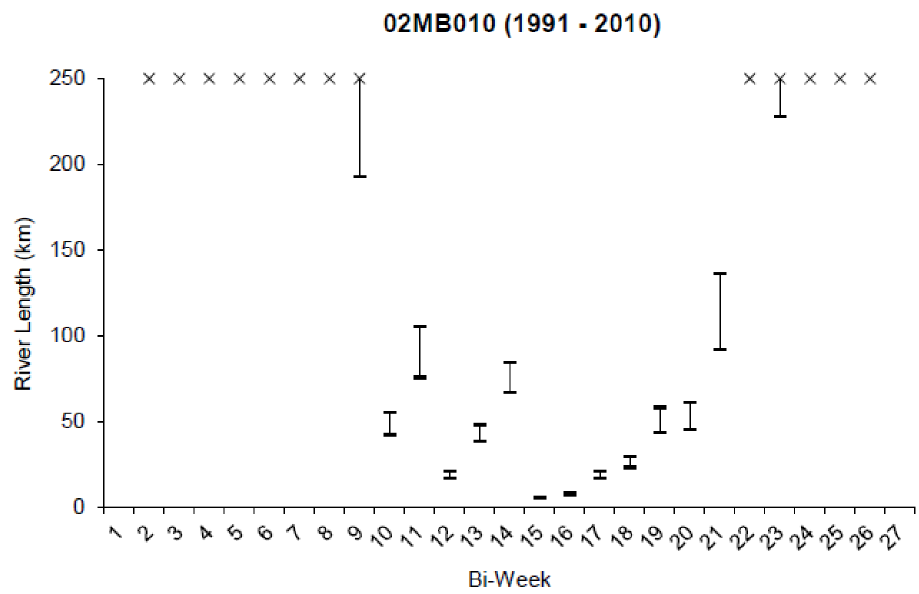


Figure A1-217. Gauging station 02HM011 data from 2006–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum) lines.



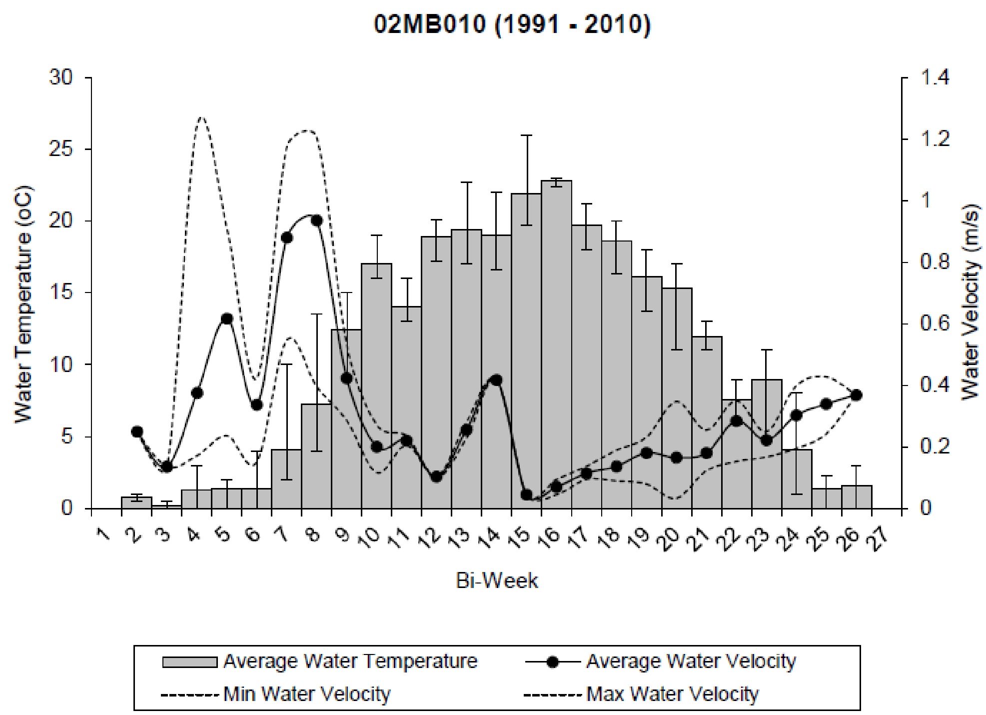
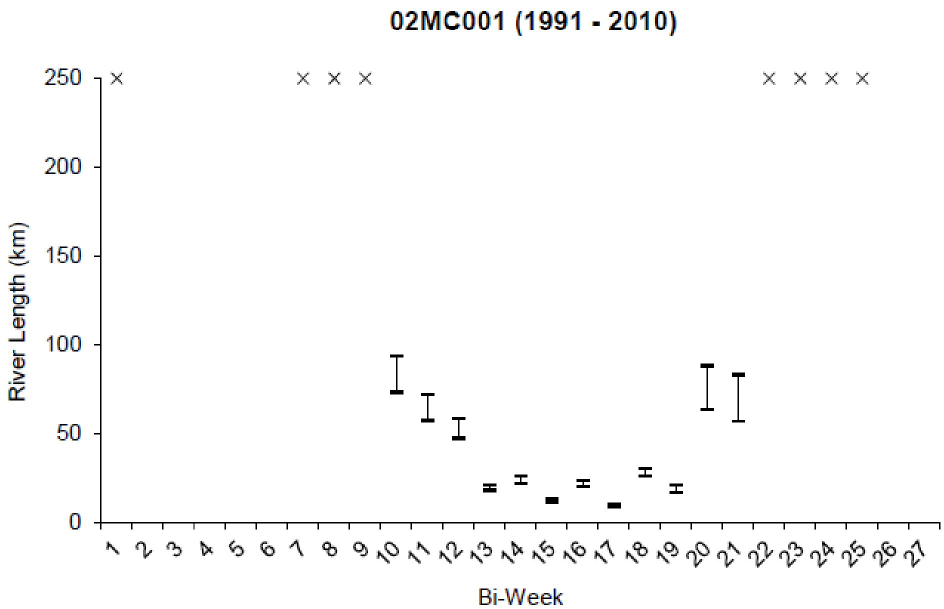


Figure A1-218. Gauging station 02MB010 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum).



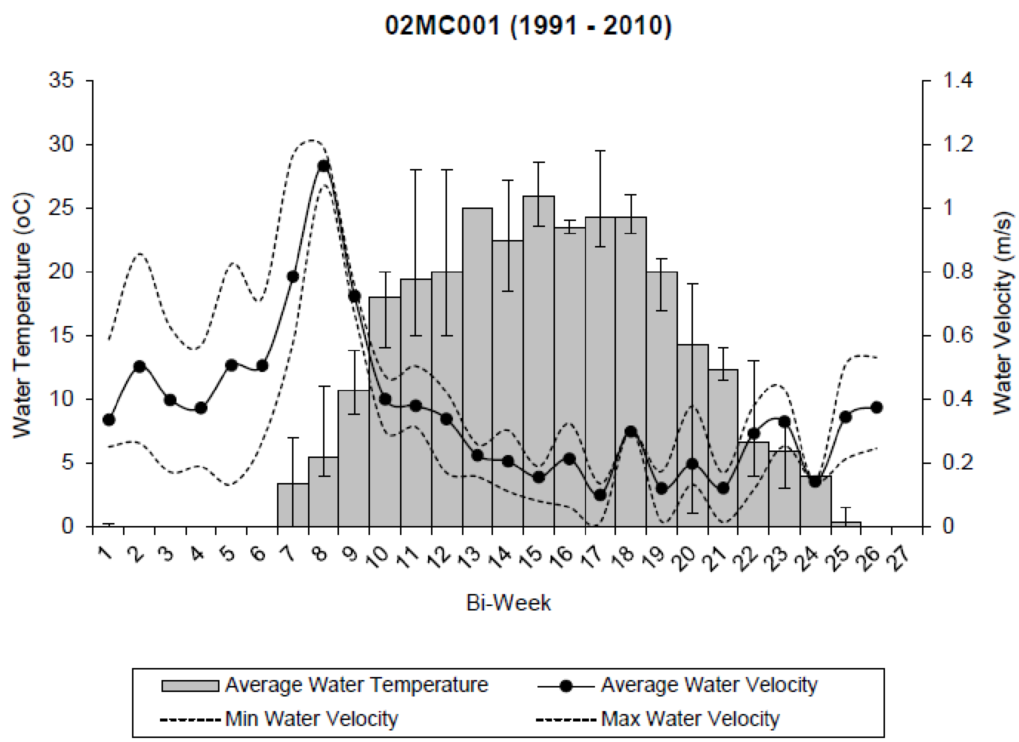
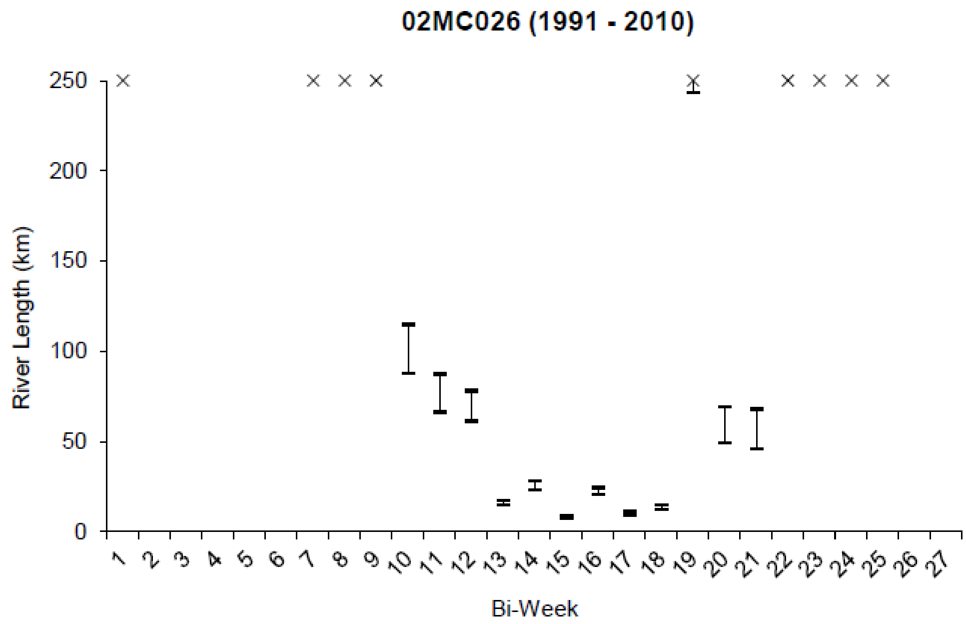


Figure A1-219. Gauging station 02MC001 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum).



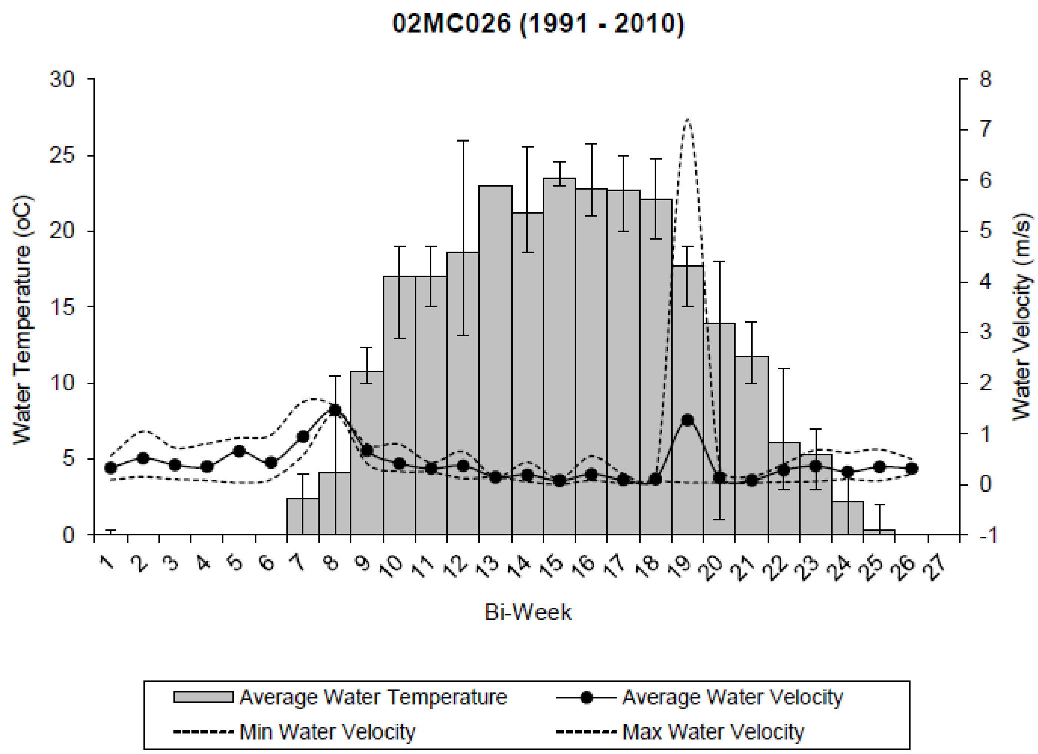
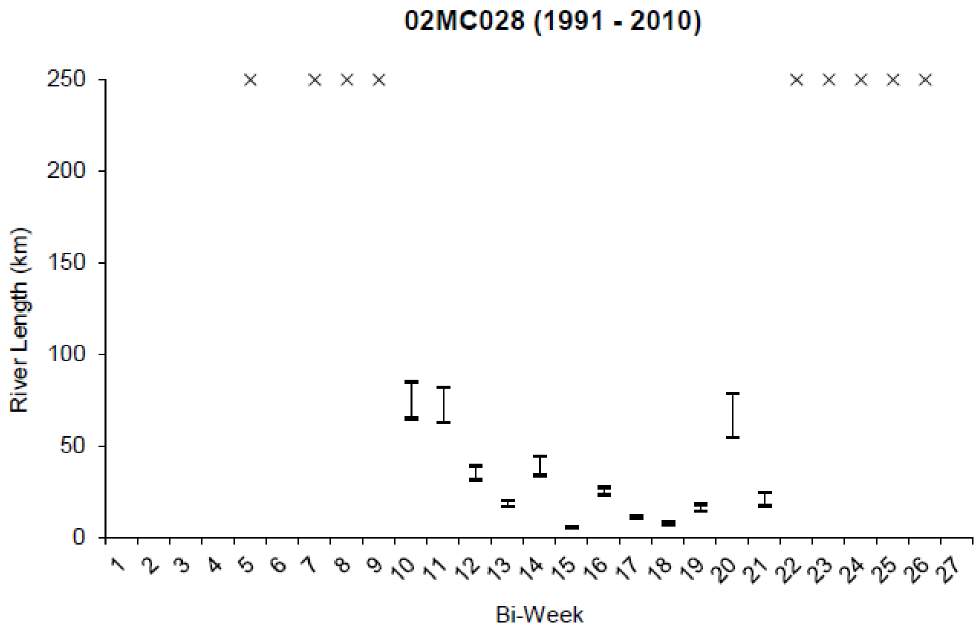


Figure A1-220. Gauging station 02MC026 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum).



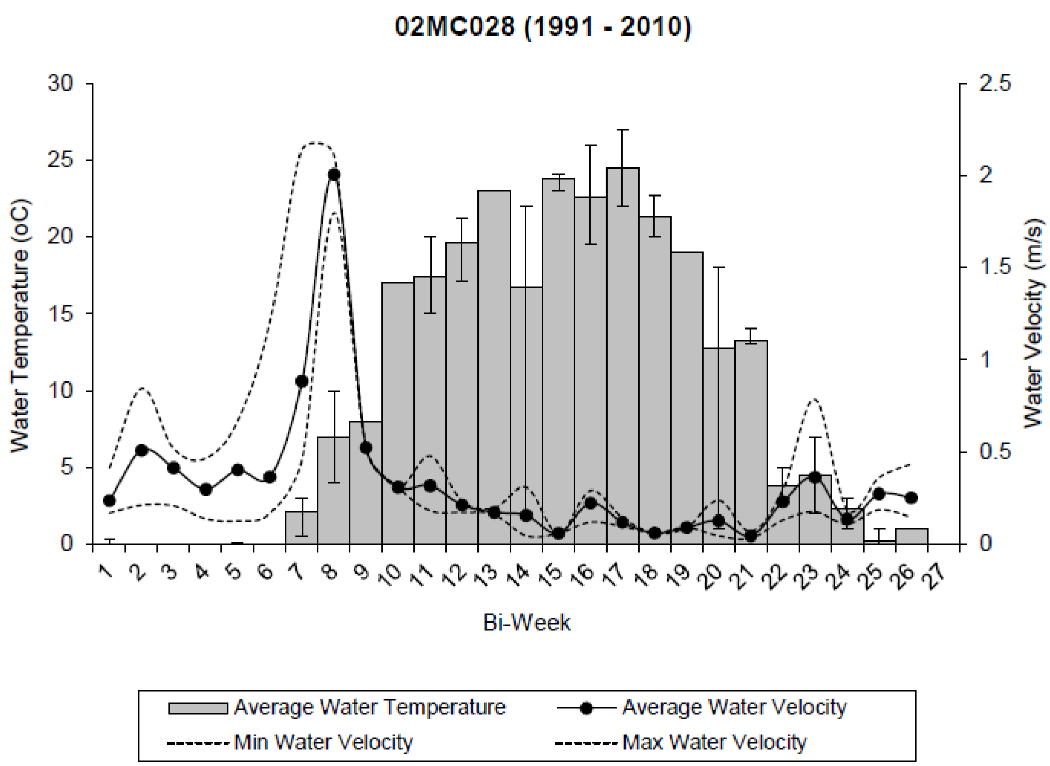
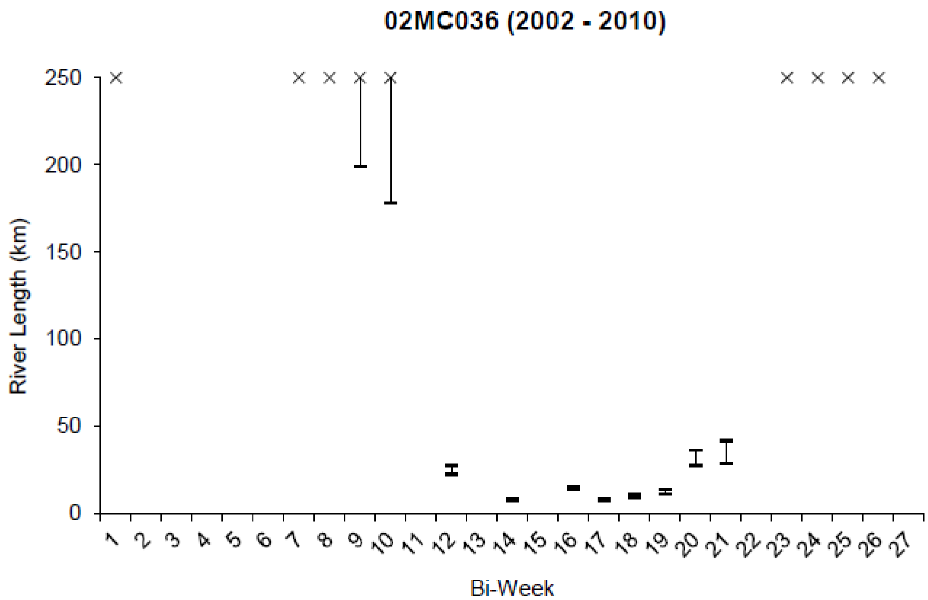


Figure A1-221. Gauging station 02MC028 data from 1991–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum).



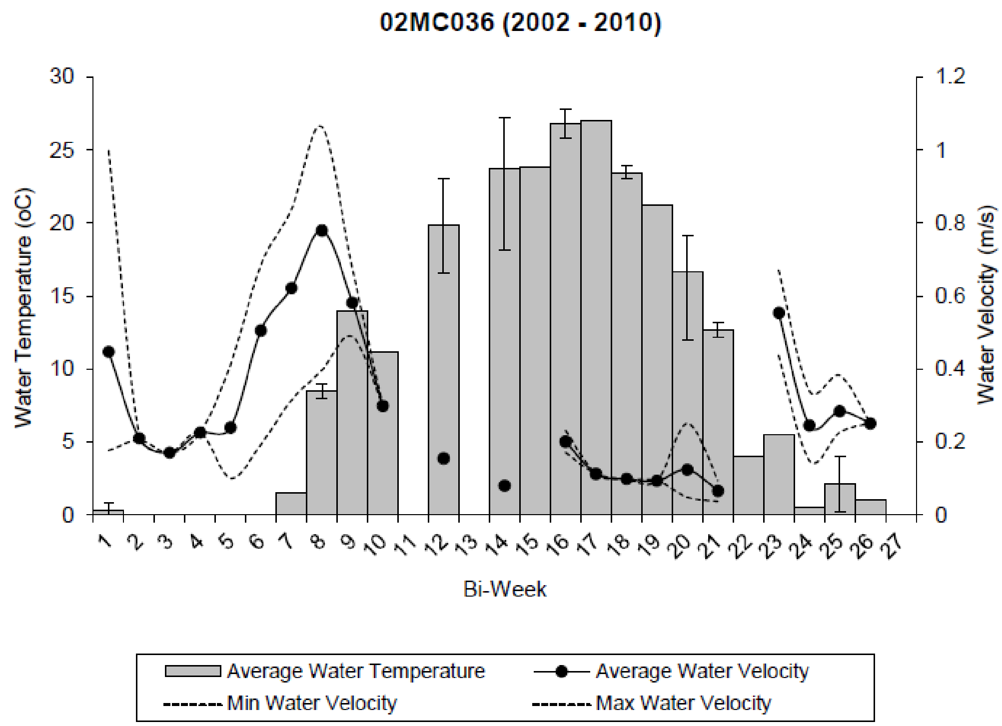


Figure A1-222. Gauging station 02MC036 data from 2002–2010. Top graph: The bars represent the range of river length required for egg drift and hatch based on water velocity and water temperature requirements. Horizontal lines on each bar represent, from top to bottom: averages using Anonymous (1970); averages using Chang (1966); maximum values using Anonymous (1970); and, maximum values using Chang (1966). Bottom graph: The grey bars represent the average water temperature. Water velocity is represented by solid (average) and dashed (minimum and maximum).

APPENDIX 2. TRIBUTARY SUITABILITY RESULTS

Table A2-1. Evaluation of tributary suitability for Asian carp spawning by stream gauging station using decision tree (see Figure 3). Suitability: 0 – not suitable; 1 – suitable; 2 – highly suitable.

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Superior	02AB008	Neebing River near Thunder Bay	McIntyre River	52.51	16...19	75, 12.5, 20, 70	12.5	16	-	17, 18, 19	-	1	-
Superior	02AB014	North Current River near Thunder Bay	Current River	< 1	17, 18	40, 25	25	20, 21	20, 21	-	-	0	too short
Superior	02AB017	Whitefish River at Nolalu	Mission River	151.77	16...18	25, 25, 50	25	20	-	-	-	0	no spike
Superior	02AB019	McVicar Creek at Thunder Bay	Dog River	22.63	17, 18	10, 10	10	20	-	-	-	0	no spike
Superior	02AB020	McIntyre River above Thunder Bay	McIntyre River	52.51	17, 18	25, 30	25	19, 24	-	-	-	0	no spike
Superior	02AB021	Current River at Stepstone	Current River	< 1	14, 17, 18	100, 40, 60	40	18, 20	-	-	-	0	too short
Superior	02AB022	Corbett Creek near Murillo	Mission River	151.77	14...19	10, 10, 20, 10, 30	10	21	21	-	-	0	no spike
Superior	02AB024	Neebing River near Intola	McIntyre River	52.51	15	10, 30	10	21	21	-	-	0	spike too late
Superior	02AE001	Gravel River near Cavers	Gravel River	95.34	17, 18	55	55	19	-	17	-	1	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Superior	02BA003	Little Pic river near Coldwell	Little Pic River	168.77	16, 19	100	100	17	17	17	17	2	-
Superior	02BA006	Steel River below Santoy Lake	Steel River	~ 15	18, 19	10, 60	10	19	-	19	-	1	-
Superior	02BB003	Pic River near Marathon	Pic River	229.26	16...18	20	20	18	-	18	-	1	-
Superior	02BB004	Cedar Creek near Hemlo	Pic River	229.26	15... 19	10, 25, 15, 20, 70	10	16, 21	-	-	-	0	no spike
Superior	02BC005	Pukaskwa River at Pukaskwa NP	Pukaskwa River	89.11	16...18	40, 50, 60	40	16, 17, 18	-	17, 18	-	1	-
Superior	02BF001	Batchawana River near Batchawana	Batchawana River	133.05	14...19	50,50,50, 50,50,50	50	-	-	-	-	0	no spike
Superior	02BF002	Goulais River near Searchmont	Goulais River	183.79	-	-	-	-	-	-	-	0	no spike
Superior	02BF004	Big Carp River near Sault Ste. Marie	Big Carp River	19.43	13...19	50,25,x,50, 25,40,25	25	13,16, 18	-	-	-	0	too short
Superior	02BF005	Norberg Creek (Site A) above Batchawana River	Batchawana River	133.05	14...19	40,25,30, 35,40	25	16, 24	-	-	-	0	no spike

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Superior	02BF006	Norberg Creek (Site B) at outlet of Turkey Lake	Batchawana River	133.05	14...20	20,25,35, 30,40,45	20	16, 20	-	-	-	0	no spike
Superior	02BF007	Norberg Creek (Site C) at outlet of Little Turkey Lake	Batchawana River	133.05	13...20	20,20,15, 25,25,40	20	16, 21	-	-	-	0	no spike
Superior	02BF008	Norberg Creek (Site D) below Wishart Lake	Batchawana River	133.05	14...19	40,40,40, 45,50	40	16, 20	-	-	-	0	no spike
Superior	02BF012	Norberg Creek (Site F) at outlet of Batchawana	Batchawana River	133.05	14...20	20,15,25, 10,25, 30,50	10	-	-	-	-	0	no spike
Huron	02CA002	Root River at Sault Ste. Marie	Garden River	41.3	14...20	15,x,20,25, 20,x	15	16, 20	-	16,20	-	1	-
Huron	02CC008	Mississagi River at Mississagi Chute	Mississagi River	56.75	14...16	x,40,60	40	-	-	-	-	0	too short
Huron	02CD001	Serpent River at Highway No. 17	Serpent River	125.91	13...19	50,40,50, 55,45,60, 10,0	40	16,18, 19	-	16,18, 19	-	1	-
Huron	02CD002	Serpent River at outlet of Dunlop Lake	Serpent River	125.91	14...20	50,40,35, 20,45,45, 125	20	18,20	-	18,20	-	1	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02CD003	Serpent River below Quirke Lake	Serpent River	125.91	15...20	50,60,50, 60,55	50	16,18, 20	20	16,18	20	2	-
Huron	02CD004	Serpent River below Pecors Lake	Serpent River	125.91	14...18	35,35,40, 45,45	35	17	-	17	-	1	-
Huron	02CD006	Serpent River above Quirke Lake	Serpent River	125.91	14...20	45,45,40, 35,70,40	35	18,20	-	18,20	-	1	-
Huron	02CE002	Aux Sables River at Massey	Spanish River	152.34	15...18	60,65,75, 80	60	15,17, 19	17	17	-	1	-
Huron	02DB005	Wanapitei River near Wanup	Wanapitei River	~ 70	14...19	30,x,25,35, 45,55	25	17,21	21	17	-	1	-
Huron	02DB007	Coniston Creek above Wanapitei River	Wanapitei River	~ 70	13...18, 20	50,25,30, 35,30,50, 175,100	25	14,16, 19	19	14,16	-	1	-
Huron	02DD010	French River at Dry Pine Bay	French River	107.8	14,x,16.. .19	45,x,45,50, 45,50	45	14,20	20	14	-	1	-
Huron	02DD015	Commanda Creek near Commanda	French River	107.8	14...19	40,45,50, 25,110,100	40	16	-	16	-	1	-
Huron	02DD016	French River at Portage Dam	French River	107.8	16...19	x,25,x,150	25	19	19	-	-	2	-
Huron	02DD017	French River at Chaudiere Dam	French River	107.8	14...19	20,80,x,50, x,110	20	15,16	15,16	-	15, 16	2	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02DD020	Little French River at Okikendawt Island	French River	107.8	15...18	100,100, 60,65	60	15,16, 19	15,16, 19	-	15,16, 19	2	-
Huron	02EA005	North Magnetawan River near Burk's Falls	Magnetawan River	32.78	11...19	25,40,40, 35,30,125, 100	25	14,18	-	14	-	1	-
Huron	02EA006	Magnetawan Riveer near Burk's Falls	Magnetawan River	32.78	13...19	25,55,55, 55,55, 75,80	25	15,18	18	-	-	0	too short
Huron	02EA010	North Magnetawan River above Pickerel Lake	Magnetawan River	FALSE	14...18	15,90,30, 50,70	15	-	-	-	-	0	no spike
Huron	02EA011	Magnetawan River near Britt	Magnetawan River	32.78	14...19	50,60,55, 50,140	50	15,18	15,18	-	-	0	too short
Huron	02EB011	Moon River at Highway No. 69	Moon River	34.67	15...20	20,x,45,40, x,75	20	17,20	-	-	-	0	too short
Huron	02EC005	Severn River at Washago	Severn River	~ 1	13...19	45,35,25,x, 45,55,30	25	18	18	-	-	0	too short
Huron	02EC006	Severn River at Big Falls	Severn River	~ 1	13...18	100,90,x, 40,55,50	40	13,17	17	-	-	0	too short
Huron	02EC007	Severn River at Little Falls	Severn River	~ 1	14...20	125,60,x, 50,25,x, 250	25	14,20	14,20	-	-	0	too short
Huron	02EC008	Black River at Baldwin	Severn River	~ 1	12...20	30,40,25, 25,30,20, 25,50,60	20	16,19, 20	-	-	-	0	too short

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02EC013	Middle Severn River at Washago	Severn River	~ 1	14...18	x,25,x,20, 20	20	18	-	-	-	0	too short
Huron	02EC014	Severn River above Wasdell Falls	Severn River	~ 1	14...20	x,20,x,30, 45,40,30	20	18,20	-	-	-	0	too short
Huron	02ED003	Nottawasaga River near Baxter	Nottawasaga River	115.23	13...20	25,25,20, 30,40,30, 70,80	25	14,16	-	14,16	-	1	-
Huron	02ED007	Coldwater River at Coldwater	North River	44.74	14...19	60,60,40, 10,60,75	40	14,16, 18,20	20,20	14	-	1	-
Huron	02ED010	Willow Creek at Midhurst	Nottawasaga River	115.23	13...18	20,30,25, 30,35,40	20	14,17, 19	-	14,17, 19	-	1	-
Huron	02ED013	Wye River near Wyevale	Wye River	1.5	13...19	30,30,40, 20,20,30, 50	20	13,14, 15,18	-	-	-	0	too short
Huron	02ED017	Hog Creek near Victoria Harbour	Hog Creek	27.42	13...18	20,20,25, 20,x,40	20	13,15	-	15	-	1	-
Huron	02ED018	Sturgeon River at Sturgeon Bay	Sturgeon River	33.59	13...16	25,20,30, 15	15	13,15	-	15	-	1	-
Huron	02ED019	Copeland Creek near Penetaguishe ne	Copeland Creek	10.45	14...18	25,10,160, x,110	10	14,16, 18	-	15	-	1	-
Huron	02ED024	North Fiver at the falls	North River	44.74	12...19	80,70,75, 60,55,45, 50,45	45	12,15, 16	-	-	-	0	too short

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										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02ED026	Nottawasaga River at Hockley	Nottawasaga River	FALSE	15...18	60,50,75, 80	50	15,17	-	15,17	-	1	-
Huron	02ED031	Pretty River at Collingwood	Pretty River	25.69	16...19	50,25,40, 45	25	16,19	-	16,19	-	1	-
Huron	02ED032	Willow Creek near Minesing	Nottawasaga River	115.23	13...18	70,120,85, 90,70,75	70	15	-	15	-	1	-
Huron	02ED101	Nottawasaga River near Alliston	Nottawasaga River	115.23	13...19	60,60,45, 60,60, x,100	45	14,16, 19	-	14,16, 19	-	1	-
Huron	02FA001	Sauble River at Sauble Falls	Sauble River	55.28	13...19	150,40,80, 40,70,80, 70	40	13,15, 17	13,15, 17	14	16	2	-
Huron	02FA002	Stokes River near Ferndale	Stokes River	19.84	13...19	25,20,20, 15,25, 20,50	15	17	-	17	-	1	-
Huron	02FA004	Sauble River at Allenford	Sauble River	55.28	13...19	75,30,30, 25,25, 25,30	25	13,14	-	14	-	1	-
Huron	02FB007	Sydenham River near Owen Sound	Sydenham River	8.36	14...18	60,45,45, 55,45	45	16	-	-	-	0	too short
Huron	02FB009	Beaver River near Clarksburg	Beaver River	~ 20	14...19	50,50,65, 60,x,80	50	14,16	-	14,16	-	0	too short
Huron	02FB010	Bighead River near Meaford	Bighead River	No barrier	14...19	60,40,30, 30,30,50	30	14	14	14	-	1	-

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										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02FC001	Saugeen River near Port Elgin	Saugeen River	8 (fishway)	15...19	50,45,x,50, 110	45	15,19	-	-	-	0	too short
Huron	02FC002	Saugeen River near Walkerton	Saugeen River	8 (fishway)	14...19	50,25,30, 25,25,60	25	14,16	-	-	-	0	too short
Huron	02FC012	South Saugeen River near Hanover	Saugeen River	8 (fishway)	14...19	40,20,25, 20,40,40	20	14,18	-	-	-	0	too short
Huron	02FC015	Teeswater River near Paisley	Saugeen River	8 (fishway)	13...19	75,40,25, 20,40, 20,25	20	13,17	13	-	-	0	too short
Huron	02FC016	Saugeen River above Durham	Saugeen River	8 (fishway)	14...20	40,50,45, 25,45,150, 75	25	19	19	-	-	0	too short
Huron	02FC017	Beatty Saugeen River near Holstein	Saugeen River	8 (fishway)	15...19	40,15,35, 30,55	15	15,17, 19	-	-	-	0	too short
Huron	02FC018	North Saugeen River above Chesley	Saugeen River	8 (fishway)	14...H13 017	80,40,20, 60	20	14,17	-	-	-	0	too short
Huron	02FC020	Teeswater River at Teeswater	Saugeen River	8 (fishway)	15...20	45,x,25,10, x,55	10	-	-	-	-	0	no spike
Huron	02FD001	Pine River at Lurgan	Pine River	40.08	13...20	35,25,30, 25,25,10, 135	10	17	19	17	19	2	-
Huron	02FD002	Lucknow River at Lucknow (9 mile)	Lucknow River	~ 4 (fishway)	14...19	20,25,20, 15,15,140	15	-	19	-	-	0	too short

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										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02FD003	North Penetangore River at Kincardine	Penetangore River	40.44	13…20	25,30,10, 10,15,25, x,15	15	14,18	-	14,18	-	1	-
Huron	02FE002	Maitland River below Wingham	Maitland River	117.3	14…19	25,25,20, 25,30,30	20	14,18	-	14,18	-	1	-
Huron	02FE003	Middle Maitland River near Listowel	Maitland River	117.3	13…20	40,20,20, 25,20,25, 50,40	20	13,16	20	16	20	2	-
Huron	02FE005	Maitland River above Wingham	Maitland River	117.3	13…20	30,30,25, 40,35,20, 100,110	25	14,16	19	14,16	19	2	-
Huron	02FE007	Little Maitland River at Bluevale	Maitland River	117.3	13…20	60,30,25, 20,30, 25,50	20	13,17, 19	-	17,19	-	1	-
Huron	02FE008	Middle Maitland River near Belgrave	Maitland River	117.3	12…21	40,55,20, 25,20,20, 20,100,140	20	-	13,19	-	19	2	-
Huron	02FE009	South Maitland River at Summerhill	Maitland River	117.3	14…20	50,25,25, 25,25, 75,75	25	16	19	16	19	2	-
Huron	02FE011	Maitland River near Harriston	Maitland River	117.3	12…19	50,40,25, 15,20,20, 25,20	15	12,16, 18,20	-	16,18, 20	-	1	-
Huron	02FE013	Middle Maitland River above Ethel	Maitland River	117.3	14…20	25,50,45, 25,30,100, 210	25	-	15,16, 19,20	-	15,16, 19	2	-
Huron	02FE014	Blyth Brook below Blyth	Maitland River	117.3	13…19	25,25,25, 20,25, 25,60	20	13,15, 19	-	15,19	-	1	-

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										Bi-weeks	Bi-weeks > 0.7m/s		
Huron	02FE015	Maitland River at Benmiller	Maitland River	117.3	15…20	30,90,25, 50,55	25	16,18	-	16,18	-	1	-
Huron	02FE016	South Maitland River at Roxboro	Maitland River	117.3	13…20	20,x,x,15, x,x,40,x	15	-	-	-	-	0	no spike
Huron	02FF002	Ausable River near Springbank	Ausable River	148.83	13…19	40,55,35, 30,25, 55,25	25	-	14,18	-	14,18	2	-
Huron	02FF004	South Parkhill Creek near Parkhill	Ausable River	76.48	13…19	20,15, 25,5,25, 30,45	5	15,17, 19	-	15,17, 19	-	1	-
Huron	02FF007	Bayfield River near Varna	Bayfield River	83.26	13…20	20,20,35, 20,20, 30,40	20	-	16	-	16	2	-
Huron	02FF008	Parkhill Creek above Parkhill Reservoir	Ausable River	76.48	13…19	50,25,15, 10,20, 60,80	15	14,18, 19	-	14,18, 19	-	1	-
Huron	02FF009	Ausable River near Exeter	Ausable River	148.83	13…20	40,75,20, 15,20,30, 50,60	15	20	14	20	14	2	-
Huron	02FF011	Silver Creek at Seaforth (Bayfield Trib)	Bayfield River	83.26	13…20	15,30,30, 20,10,10, 15,x	15	13,14, 15	-	14,15	-	1	-
Huron	02FF012	Perch Creek at Sarnia	Cow Creek	23.96	13…20	20,15,x,5, 10,25,x,25	5	18	-	18	-	1	-
Huron	02FF015	Tricks Creek near Clinton	Bayfield River	83.26	15...17	20,20,x	20	-	-	-	-	0	no spike

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										Bi-weeks	Bi-weeks > 0.7m/s		
Erie	02GA003	Grand River at Galt	Grand River	150	14…20	50,50,75, 60,x, 80,125	50	-	-	-	-	0	no spike
Erie	02GA010	Nith River near Canning	Grand River	150	13…19	55,40,50, 55,x,100	40	-	15,18, 19	-	15,18, 19	2	-
Erie	02GA014	Grand River near Marsville	Grand River	150	13…20	50,15,30, 30,25,40, 30,30	15	13,15, 16,18	-	15,16, 18	-	1	-
Erie	02GA016	Grand River below Shand Dam	Grand River	150	15…20	45,40,50, 45,100,125	40	15	19	15	19	2	-
Erie	02GA018	Nith River at new Hamburg	Grand River	150	13…19	25,20,25, 25,25,30	20	-	19	-	19	2	-
Erie	02GA034	Grand River at west Montrose	Grand River	150	13…20	90,50,75, 50,55,80, 175	50	-	15,18	-	15,18	2	-
Erie	02GA041	Grand River near Dundalk	Grand River	150	14…19	25,25,25, 40,15,45	15	17,20	-	17,20	-	1	-
Erie	02GB001	Grand River at Brantford	Grand River	150	13…19	85,55,50, 55,60, 55,65	50	-	14,19	-	14,19	2	-
Erie	02GB007	Fairchild Creek near Brantford	Grand River	150	13…21	50,45,55, 60,50,65, 75,95,250	45	13,18	16,21	18	16,21	2	-
Erie	02GB008	Whitemans Creek near Mount Vernon	Grand River	150	13…20	70,40,40, 50,45, 35,55	35	-	13,16, 20	-	16,20	2	-
Erie	02GC002	Kettle Creek at St. Thomas	Kettle Creek	~ 30	13…19	40,20,25, 15,20, 25,30	15	13,15, 18	-	15,18	-	1	-

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										Bi-weeks	Bi-weeks > 0.7m/s		
Erie	02GC006	Big Creek near Delhi	Big Creek	62.23	14…20	40,30,45, 60,55, 60,95	30	16,17, 19	-	16,17, 19	-	1	-
Erie	02GC007	Big Creek near Walsingham	Big Creek	62.23	13…20	55,60,45, 40,45,60, 65,100	40	14,16, 20	-	14,16	-	1	-
Erie	02GC008	Lynn River at Simcoe	Lynn River	~ 10	13…19	70,55,30, 45,50,65, 60,180	30	13,17, 18	14	-	-	0	too short
Erie	02GC010	Big Otter Creek at Tillsonburg	Big Otter Creek	~ 80	13…19	70,40,30, 25,45, 35,60	25	17,19	13	17,19	-	1	-
Erie	02GC011	Big Creek near Kelvin	Big Creek	62.23	14…18	x,15,x,30,x	15	17	-	17	-	1	-
Erie	02GC012	Patterson Creek near Simcoe	Big Otter Creek	~ 10	13…17	50,15,30, 35,25	15	13	-	-	-	0	too short
Erie	02GC014	Young Creek near Vittoria	Big Otter Creek	~ 20	13…18	100,95, 140,x,80, 65	65	15,18	14	-	-	0	too short
Erie	02GC015	Little Otter Creek near Straffordville	Big Otter Creek	~ 80	13…19	65,30,40, 30,40, 40,75	30	15,17,1 9	13	15,17, 19	-	1	-
Erie	02GC017	Big Otter Creek above Otterville	Big Otter Creek	~ 80	13…20	50,30,60, 40,35, 70,55,80	30	13,16, 18,20	-	16,18	-	1	-
Erie	02GC018	Catfish Creek near Sparta	Catfish Creek	62.57	13…20	30,30,35, 30,15,35, 45,140	15	15,18	20	15,18	-	1	-
Erie	02GC021	Venison Creek near Walsingham	Big Creek	62.23	13…19	50,40,35, 40,35,45, 75,190	35	13,16, 18,19, 20	-	16,18, 19	-	1	-

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										Bi-weeks	Bi-weeks > 0.7m/s		
Erie	02GC022	Nanticoke Creek at Nanticoke	Nanticoke Creek	47.95	13…19	30,25,20, 20,20,35, 60	20	13,17	19	17	19	2	-
Erie	02GC026	Big Otter Creek near Calton	Big Otter Creek	~ 80	13…20	40,60,25, 35,45,45, 80,90	25	14,17,1 9	-	14,17,1 9	-	1	-
Erie	02GC029	Kettle Creek above St. Thomas	Kettle Creek	~ 30	13…20	20,15,20, 10,15,65, 35	10	15	18,20	15	18	2	-
Erie	02GC030	Catfish Creek at Aylmer	Catfish Creek	62.57	13…21	20,15,10, 15,15,15, 35,60,60	10	15,19	-	15,19	-	1	-
Erie	02GC031	Dodd Creek below Paynes Mills (Kettle)	Kettle Creek	~ 30	13…19	30,30,30, 20,10, 14,60	10	13,15,1 9	-	15,19	-	1	-
Erie	02GD001	Thames River near Ealing	Thames River	243.65	13…20	55,15,25, 30,25,35, 45,90	15	15,16, 18,19	-	15,16,1 8,19	-	1	-
Erie	02GD003	North Thames River below Fanshawe Dam	Thames River	243.65	13…19	40,x,25,20, 40,20,45	20	13,17,1 9	-	17,19	-	1	-
Erie	02GD004	Middle Thames River at Thamesford	Thames River	243.65	13…20	25,15,15, 20,20,20, 35,50	15	13,15,2 0	-	15,20	-	1	-
Erie	02GD005	North Thames river at St. Marys	Thames River	243.65	13…19	60,20,40, 60,40, 50,90	20	16,19	15	16,19	15	2	-

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										Bi-weeks	Bi-weeks > 0.7m/s		
Erie	02GD012	Thames River at Woodstock	Thames River	243.65	13…20	20,35,25, 25,25, 35,20	20	14,18, 20	-	14,18, 20	-	1	-
Erie	02GD014	North Thames River near Mitchell	Thames River	243.65	14…19	25,15,15, 10,30,30	10	15,18, 20	-	15,18, 20	-	1	-
Erie	02GD015	North Thames River near Thorndale	Thames River	243.65	13…20	70,75,25, 25,35,40, 90,135	25	18,20	15,19	18,20	15,19	2	-
Erie	02GD016	Thames River at Ingersoll	Thames River	243.65	13…19	45,130,30, 30,55,45, 60,170	30	17,20	14	17,20	14	2	not directly connected to St. Clair
Erie	02GD021	Thames River at Innerkip	Thames River	243.65	13…20	15,20,20, 35,45,40, 55,110	15	-	17,18, 20	-	17,18, 20	2	-
Erie	02GD023	Thames River near Tavistock	Thames River	243.65	13…20	20,5,20,20, 20,35,15, 45	5	15,18, 20	-	15,18, 20	-	1	-
Erie	02GE002	Thames River at Byron	Thames River	243.65	15…20	45,15,55, x,x,55	15	17	-	17	-	1	-
Erie	02GE003	Thames River at Thamesville	Thames River	243.65	13…20	85,35,70, 35,50, 60,75	35	-	14,16, 20	-	14,16, 20	2	-
Erie	02GE006	Thames River near Dutton	Thames River	243.65	15…20	25,x,45,60, 75,110	25	-	-	-	-	0	no spike
Erie	02GG002	Sydenham River near Alvinston	Sydenham River	156.66	13…20	40,15,15,x, 20,45, 15,30	15	-	13,18	-	18	2	-
Erie	02GG003	Sydenham River at Florence	Sydenham River	156.66	13…20	50,25,25, 25,30,55, 40,45	25	-	-	-	-	0	no spike

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Erie	02GG005	Sydenham River at Strathroy	Sydenham River	156.66	14…20	10,15,10, 25,20,35, 30	10	15,17, 19	-	15,17, 19	-	1	-
Erie	02GH001	Sturgeon Creek near Leamington	Sturgeon Creek	12.89	13…19	5,5,5,15, 20,15,30	5	14,16, 17,19	-	14,16	-	1	-
Erie	02GH002	Ruscom River near Ruscom Station	Ruscom River	34.43	13…20	35,5,10,10, 15,15,70, 35	5	15,17, 19	13	15,17	-	1	-
Erie	02GH003	Canard River near Lukerville	Canard River	53.56	13…20	20,10,30, 10,20,15, 30,35	10	17,19	15	17,19	15	2	-
Erie	02GH004	Turkey Creek at Windsor	Turkey Creek	14.43	12…21	70,55,40, 50,35,35, 50,80,75, 110	35	-	12,15, 20	-	-	0	too short
Erie	02GH011	Little River at Windsor	Little River	16.7	12…20	10,21,5,5, 5,10,10, 25,25	5	13,17, 20	-	17	-	1	-
Ontario	02HA006	Twenty Mile Creek at Balls Falls	Twenty Mile Creek	~ 10	12…20	55,40,10, 15,15,35, 10,35,35	10	12,19	17	-	-	0	too short
Ontario	02HA007	Welland River below Caistor Corners	Welland River	~ 100	13…20	15,25,15, 20,25,20, 35,60	15	14,17, 20	-	17,20	-	1	-
Ontario	02HA014	Redhill Creek at Hamilton	Redhill Creek	18.95	13…19	15,20,20, 120,15, 10,20	10	16	-	-	-	0	too short
Ontario	02HA022	Stoney Creek at Stoney Creek	Stoney Creek	16.74	14…19	20,100,20, 15,x,35	15	19	15	-	-	0	too short

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HA023	Redhill Creek at Albion Falls	Redhill Creek	18.95	13…19	45,30,50, 85,30,x,70	30	16,19	-	-	-	0	too short
Ontario	02HA024	Oswego Creek at Canboro	Oswego Creek	~ 100	12…18	35,15,10, 20,10,10	10	12,15	-	-	-	1	-
Ontario	02HA030	Four Mile Creek near Virgil	Four Mile River	~ 10	12…17	x,5,20,x, x,25	5	14	-	-	-	0	too short
Ontario	02HB001	Credit River near Cataract	Credit River	30.15	13…18	35,70,45, 40,70,40	35	17,19	-	17,19	-	1	-
Ontario	02HB002	Credit River at Erindale	Credit River	30.15	14…19	80,50,55,x, 150,70	50	-	14,18	-	-	0	too short
Ontario	02HB004	East Oakville Creek near Omagh	Sixteen Mile Creek	63.39	14…19	15,15,10, 15,120,30	10	-	18	-	-	2	-
Ontario	02HB005	Oakville Creek at Milton	Sixteen Mile Creek	63.39	14…19	40,40,15, 30,60,70	15	15	18	15	18	2	-
Ontario	02HB007	Spencer Creek at Dundas	Spencer Creek	17.9	14…20	45,55,35, 35,45,50, 100	35	20	15,18	-	-	0	too short
Ontario	02HB008	Credit River West Branch at Norval	Credit River	30.15	14…20	50,50,25, 30,55, 95,105	25	-	15,18, 19	-	15,18	2	-
Ontario	02HB011	Bronte Creek near Zimmerman	Bronte Creek	38.21	14…18	40,30,30, 85,45	30	15	17	15	-	1	-
Ontario	02HB012	Grindstone Creek near Aldershot	Grindstone Creek	18.82	13…19	30,20,30, 30,25, 35,35	20	15,17	-	-	-	0	too short

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HB013	Credit River near Orangeville	Credit River	30.15	13…18	15,30,20, 15,25	10	14,18	-	18	-	1	-
Ontario	02HB015	Spencer Creek near Westover	Credit River	17.9	13…20	15,10,10, 10,25,15, 15,25	10	15	17	15	-	1	-
Ontario	02HB018	Credit River at Boston Mills	Credit River	30.15	14…19	90,80,75, 70,95,120	70	-	16,20	-	-	0	too short
Ontario	02HB019	Credit River Alton Branch above Alton	Credit River	30.15	14…18	15,20,10, 25,40	10	14,18	-	18	-	1	-
Ontario	02HB020	Credit River Erin Branch Above Erin	Credit River	30.15	13…19	40,45,35, 25,50, 50,75	25	13,15, 17,19	-	15,17, 19	-	1	-
Ontario	02HB021	Ancaster Creek at Ancaster	Ancaster Creek	17.9	13…19	60,30,15,x, 20,15,60	15	19	-	-	-	0	too short
Ontario	02HB022	Bronte Creek at Carlisle	Bronte Creek	38.21	13…19	35,25,85, 15,15, 50,25	15	18	15	-	-	0	too short
Ontario	02HB023	Spencer Creek at Highway No. 5	Spencer Creek	17.9	14…20	10,10,10, 20,30,20, 70	10	17,20	-	-	-	0	too short
Ontario	02HB025	Credit River at Norval	Credit River	~ 70	14…20	50,70,65, 50,85, 90,150	50	-	15,16, 18,20	-	15,16	2	-
Ontario	02HB027	Fourteen Mile Creek at Oakville	Fourteen Mile Creek	14.75	13…20	x,10,20, 20,15, 15,x,130	10	15,16	20	-	-	0	too short
Ontario	02HB028	Grindstone Creek near Millgrove	Grindstone Creek	17.9	14…17	20,5,20,60	5	14	17	-	-	0	too short

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HC003	Humber River at Weston	Humber River	~ 4	12…19	60,50,20, 35,45,40, 40,155	20	-	13,16, 19	-	-	0	too short
Ontario	02HC005	Don River at York Mills	Don River	50.09	14…20	85,65,x,60, 45,165,60	45	-	14,19	-	-	0	too short
Ontario	02HC009	East Humber River near Pine Grove	Humber River	~ 4	13…20	35,30,30, 35,30,45, 70,85	30	-	16,19	-	-	0	too short
Ontario	02HC013	Highland Creek near West Hill	Rouge River	25.12	13…19	75,50,45, 145,30, 70,25	25	20	13,16, 18	19	-	1	-
Ontario	02HC017	Etobicoke Creek at Brampton	Etobicoke Creek	59.16	13…19	25,25,x,10, 45,10,25	10	14,17	-	17	-	1	-
Ontario	02HC018	Lynde Creek near Whitby	Duffins Creek	35.44	14…19	20,40,20, 25,x,65	20	-	15,18	-	15	2	-
Ontario	02HC019	Duffins Creek above Pickering	Duffins Creek	27.43	13…20	45,40,50, 40,45,90, 95,95	40	18,20	-	-	-	0	too short
Ontario	02HC022	Rouge River near Markham	Rouge River	48.05	13…20	45,15,30, 40,20,75, 85,75	15	-	13,16, 18	-	16	2	-
Ontario	02HC024	Don River at Todmorden	Don River	50.09	13…19	50,30,150, 35,35,180, 205	30	-	15,18, 19	-	-	0	too short
Ontario	02HC025	Humber River at Elder Mills	Humber River	~ 4	13…20	25,30,35, 50,30, 50,60	25	14	16,19	-	-	0	too short
Ontario	02HC028	Little Rouge Creek near Locust Hill	Rouge River	48.05	13…20	25,10,20, 15,25,45, 55,40	10	13,15	18,19	15	18	2	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HC029	Little Don River at Don Mills	Don River	50.09	14…19	70,15,70, 30,x,55	15	19	14,16	-	-	0	too short
Ontario	02HC030	Etobicoke Creek below Queen Elizabeth Highway	Etobicoke Creek	59.16	13…20	40,30,45, 45,10,25, 65,45,60	10	18	15	-	15	2	-
Ontario	02HC031	West Humber River at Highway No. 7	Humber River	~ 4	13…20	30,45,15, 15,20,25, 37,90	15	17,20	14	-	-	0	too short
Ontario	02HC032	East Humber River at King Creek	Humber River	~ 4	13…19	80,15,65, 35,45, 85,35	15	13,17, 18	15	-	-	0	too short
Ontario	02HC033	Mimico Creek at Islington	Mimico Creek	33.93	13…19	80,20,10, 35,20,15, 40,130	10	12,15, 16	19	15,16	-	1	-
Ontario	02HC038	West Duffins Creek above Green River	West Duffins Creek	27.43	13…19	30,20,30, 15,25, 45,55	15	15,17	-	-	-	1	-
Ontario	02HC047	Humber River near Palgrave	Humber River	~ 4	14…19	45,40,50, 40,105,60	40	16	18	-	-	0	too short
Ontario	02HC049	Duffins Creek at Ajax	Duffins Creek	27.43	13…19	45,45,45, 30,50, 50,40	30	15	13,17	-	-	0	too short

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HC053	Little Rouge River near Dicksons Hill	Rouge River	48.05	14…19	10,40,15, x,x,65	10	15,19	-	15	-	1	-
Ontario	02HC054	Lynde Creek at Brooklin	Duffins Creek	35.44	14…19	10,40,x, 20,20,60	10	15,19	-	-	-	1	-
Ontario	02HC055	Lynde Creek Tributary near Kinsale	Duffins Creek	35.44	14…19	40,25, 30,x,60	20	15,19	-	15	-	1	-
Ontario	02HD003	Ganaraska River near Osaca	Ganaraska River	~ 75	14…19	35,45,40, 40,x,100	35	15,18	-	15,18	-	1	-
Ontario	02HD004	North West Ganaraska River near Osaca	Ganaraska River	~ 75	14…19	25,75,25, 40,x,95	25	-	15,18	-	15,18	2	-
Ontario	02HD006	Bowmanville Creek at Bowmanville	Bowmanville Creek	~ 30	14…19	20,35,40, 30,45,70	20	15	-	15	-	1	-
Ontario	02HD008	Oshawa Creek at Oshawa	Oshawa Creek	~ 30	14…20	40,30,60, 40,25, 130,110	25	-	16,19	-	-	0	too short
Ontario	02HD009	Wilmot Creek near Newcastle	Wilmot Creek	~ 30	15…19	55,35, 50,x,150	5	-	19	-	-	0	too short
Ontario	02HD010	Shelter Valley Brook near Grafton	Shelter Valley Creek	~ 30	13…19	20,20,60, 25,50, 50,55	20	-	15,17, 18	-	-	0	too short
Ontario	02HD012	Ganaraska River above Dale	Ganaraska River	~ 75	14…19	35,15,30, 55,110,95	35	14,17, 18	-	14,17	-	1	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HD013	Harmony creek at Oshawa	Harmony Creek	~ 20	14…19	25,40,15, 15,60,15	15	15	18	-	-	0	too short
Ontario	02HD014	Farewell Creek at Oshawa	Farewell Creek	~ 20	14…19	20,35,30, 25,x,70	20	15	18	-	-	0	too short
Ontario	02HD019	Cobourg Brook at Cobourg	Cobourg Brook	~ 5	14…18	40,105, 55,x,95	40	-	15	-	-	0	too short
Ontario	02HE001	Bloomfield Creek at Bloomfield	Bloomfield Creek	17.79	13…19	15,15,15, 15,10,x,30	10	14,16, 19	-	14,16	-	1	-
Ontario	02HE004	Black Creek at Milford	Black Creek	12.77	11…19	5,15,10,x, x,5,x,x,x	5	12,19	-	-	-	0	-
Ontario	02HK004	Trent River at Glen Ross	Trent River	~ 90	14…20	20,30,60, 55,55, 100,80	20	-	17,19	-	17,19	2	-
Ontario	02HK011	Mayhew Creek near Trenton	Mayhew Creek	~ 5	12…19	20,45,10,x, 10,10,x,x	10	13	-	-	-	0	too short
Ontario	02HK902	Trent River at Healey Falls(spillway)	Trent River	~ 90	14…18	15,20,20, 10,50	10	14,16, 18	-	16,18	-	1	-
Ontario	02HL001	Moira River near Foxboro	Moira River	~ 3	12…20	70,x,20,15, 15,15,10, 35,90	10	16	20	-	-	0	too short
Ontario	02HL005	Moira River near Deloro	Moira River	~ 3	13…20	30,15,15,3 0,15,15, 35,35	15	16,19	-	-	-	0	too short
Ontario	02HM003	Salmon River near Shannonville	Salmon River	~ 3	13…20	80,20,30,2 0,15,20, 55,70	15	13,15	20	-	-	0	too short
Ontario	02HM004	Wilton Creek near Napanee	Wilton Creek	59.26	14…19	10,20,30, x,20,5	10	16	-	16	-	1	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
Ontario	02HM005	Collins creek near Kingston	Collins Creek	37.65	12…19	70,30,15, 30,25,10, 30,44,x	10	12,15, 16,18	-	15,16, 18	-	1	-
Ontario	02HM006	Millhaven Creek near Millhaven	Millhaven Creek	54.81	12…19	30,15,20, 15,10,10, 25,155	10	12,14	19	-	-	0	-
Ontario	02HM007	Napanee River at Camden East	Napanee River	~ 7	12…19	70,60,25, 25,20,15, 30,40	15	13,16, 18	-	-	-	0	too short
Ontario	02HM009	West Branch Little Cataraqui Creek at Kingston	Little Cataraqui Creek	8.35	13…19	10,230,x,5, 15,20,35	5	17	14	-	-	0	too short
Ontario	02HM010	Salmon River at Tamworth	Salmon River	~ 3	13…20	75,x,x,25, x,15,25,x	15	-	13	-	-	0	too short
Ontario	02HM011	Millhaven Creek at Sydenham	Millhaven Creek	54.81	13…19	30,x,x,20, x,5,30	5	13,16, 19	-	16,19	-	1	-
St. Lawrence	02MB010	Buells Creek at Brockville	Butlers Creek	19.93	12…19	15,30,45, 5,10,15, 25,40	5	14,17, 19	-	17	-	1	-
St. Lawrence	02MC001	Raisin River near Williamstown	Raisin River	78.25	12…20	25,20,20, 10,20,10, 20,15,60	10	12,14, 16,18, 20	-	16,18, 20	-	1	-
St. Lawrence	02MC026	Riviere Beaudette near Glen Nevis	Riviere Beaudette	54.36	12…20	50,15,25, 10,20,10, 10,x,50	10	12,14, 16	19	14,16, 18,20	19	2	-
St. Lawrence	02MC028	Riviere Delisle near alexandria	Riviere Delisle	26.8	12…20	30,20,35, 5,20,10, 5,15,45	5	14,16, 20	-	16,20	-	1	-

Basin	Station Number	Station Description	Major Tributary	Unimpounded Length (km)	Biweeks > 17 °C	Min Length (km) Required (in order of biweek > 17 °C)	Min Length Required (km)	Biweeks with Flow Spike	Biweeks with Flow Spike > 0.7 m/s	Possible Spawning		Suitability	Comments
										Bi-weeks	Bi-weeks > 0.7m/s		
St. Lawrence	02MC036	Riviere Delisle near Glen Norman	Riviere Delisle	26.8	15…20	x,15,10,10, 10,30	10	16,20	-	16	-	1	-

APPENDIX 3. TRIBUTARY NAMES IN FIGURE 8

Basin	Tributary	Label ID
Erie	Big Creek	1
Erie	Big Otter Creek	2
Erie	Canard River	3
Erie	Catfish Creek	4
Erie	Grand River	5
Erie	Kettle Creek	6
Erie	Little River	7
Erie	Lynn River	8
Erie	Nanticoke Creek	9
Erie	Ruscom River	10
Erie	Sturgeon Creek	11
Erie	Sydenham River	12
Erie	Thames River	13
Erie	Turkey Creek	14
Huron	Ausable River	15
Huron	Bayfield River	16
Huron	Beaver River	17
Huron	Bighead River	18
Huron	Copeland Creek	19
Huron	Cow Creek	20
Huron	French River	21
Huron	Garden River	22
Huron	Hog Creek	23
Huron	Lucknow River	24
Huron	Magnetawan River	25
Huron	Maitland River	26
Huron	Mississagi River	27
Huron	Moon River	28
Huron	North (Coldwater) River	29
Huron	Nottawasaga River	30
Huron	Penetangore River	31
Huron	Pine River	32
Huron	Pretty River	33
Huron	Sauble River	34
Huron	Saugeen River	35
Huron	Serpent River	36
Huron	Severn River	37

Basin	Tributary	Label ID
Huron	Spanish River	38
Huron	Stokes River	39
Huron	Sturgeon River	40
Huron	Sydenham River	41
Huron	Wanapitei River	42
Huron	Wye River	43
Ontario	Ancaster Creek	44
Ontario	Black Creek	45
Ontario	Bloomfield Creek	46
Ontario	Bowmanville Creek	47
Ontario	Bronte Creek	48
Ontario	Cobourg Brook	49
Ontario	Collins Creek	50
Ontario	Credit River	51
Ontario	Don River	52
Ontario	Duffins Creek	53
Ontario	Etobicoke Creek	54
Ontario	Farewell Creek	55
Ontario	Four Mile River	56
Ontario	Fourteen Mile Creek	57
Ontario	Ganaraska River	58
Ontario	Grindstone Creek	59
Ontario	Harmony Creek	60
Ontario	Highland Creek	61
Ontario	Humber River	62
Ontario	Little Cataraqui Creek	63
Ontario	Mayhew Creek	64
Ontario	Millhaven Creek	65
Ontario	Mimico Creek	66
Ontario	Moira River	67
Ontario	Napanee River	68
Ontario	Oshawa Creek	69
Ontario	Oswego Creek	70
Ontario	Redhill Creek	71
Ontario	Rouge River	72
Ontario	Salmon River	73
Ontario	Shelter Valley Creek	74
Ontario	Sixteen Mile Creek	75
Ontario	Spencer Creek	76

Basin	Tributary	Label ID
Ontario	Stoney Creek	77
Ontario	Trent River	78
Ontario	Twenty Mile Creek	79
Ontario	Welland River	80
Ontario	West Duffins Creek	81
Ontario	Wilmot Creek	82
Ontario	Wilton Creek	83
St. Lawrence	Butlers Creek	84
St. Lawrence	Raisin River	85
St. Lawrence	Riviere Beaudette	86
St. Lawrence	Riviere Delisle	87
Superior	Batchawana River	88
Superior	Big Carp River	89
Superior	Current River	90
Superior	Dog River	91
Superior	Goulais River	92
Superior	Gravel River	93
Superior	Little Pic River	94
Superior	McIntyre River	95
Superior	Mission (Kaministiquia) River	96
Superior	Pic River	97
Superior	Pukaskwa River	98
Superior	Steel River	99