

Hibiscus and Bays Local Board Inanga Spawning Project Report 2018 – 2019



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Executive Summary

Key Statistics 2018/19

- **484 people engaged through the project this financial year**
- **Five streams monitored**
- **Five schools involved in a freshwater education programme**
- **Five community groups supported**
- **Two new spawning sites located**
- **Two sites targeted for pest control**
- **600 native plants planted along 50m of waterway**

Project Summary

This is the second year of the Hibiscus and Bays Inanga Spawning Project. In the first year, two sites (Rothesay Bay Stream and Nukumea Stream, Orewa) were targeted for survey work and community engagement. This year, whilst continuing work at these sites, three further sites were added to the project – Taiaotea Creek (Browns Bay), Awaruku Creek (Long Bay) and Stanmore Bay Stream (Stanmore Bay).

The aim of the project is to promote community and school involvement in protecting and restoring freshwater sites within the North-West Wildlink, with the end result being an improvement in freshwater and terrestrial biodiversity at these sites.

For the two existing sites, work in the 2018/19 financial year focussed on continuing to support the local community to monitor water and habitat quality and stream life at their sites, and take action to improve and restore their stream. This took the form of planting and weeding days, pest trapping and reporting of pollution incidents. Connections were also made with other organisations and groups undertaking similar work in the local area.

For the new sites, Whitebait Connection (WBC) collected baseline information, through water quality monitoring, fish and macroinvertebrate surveys, habitat assessment and pest monitoring, and then worked to involve the local community and schools in monitoring and taking action for their stream.

The project has achieved some great outcomes this year, building on work that was done in the 2017/18 financial year. Two new inanga spawning sites have been located, meaning we now **know the location of inanga spawning on three of the five project streams**, and can work towards protecting and enhancing these sites.

Five schools (Wentworth College, Orewa Primary, Long Bay Primary, Browns Bay Primary and Massey University) have participated in the project this year and have completed, or will complete, action projects to help protect the streams. Browns Bay Primary assisted with a stream planting at Rothesay Bay, and undertook a school Hikoi on the Taiaotea Creek. Orewa Primary have created interpretative signs for the Nukumea Stream. Long Bay Primary are creating a stream mural for the Awaruku Creek and Wentworth College are currently planning their action project for Term 3.

In addition to school involvement, the community have been involved at all five sites. On the Rothesay Bay Stream and Taiaotea Creek, the Bays Restoration Network has assisted with three planting days, a weeding bee and have worked with Auckland Council to get pest trapping underway at Rothesay Bay. At Stanmore Bay, WBC have been engaging with a local landowner to gain permission to survey the stream behind their property, and are working with them to design a planting plan for the site.

On the Nukumea Stream, the community group have been active in water quality and fish monitoring, pest trapping and planting. On the Awaruku Creek, WBC have been working with MERC to establish long-term monitoring on the stream, and have helped provide additional training and support to the Torbay Environment Group and Friends of Long Bay.

There is great potential to protect, continue restoring and work towards enhancing the five project streams and both the community and local schools have expressed an interest in continuing to be involved in the project, going forwards into the new financial year.

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Introduction

In the 2017/18 financial year, Hibiscus and Bays Local Board provided funding for the Whitebait Connection (WBC) to assess two stream sites in the Hibiscus and Bays Local Board area for their potential for inanga spawning; survey these sites for evidence of spawning and engage the local community (including schools) in the monitoring, protection and enhancement of these sites.

The aim of the project was to increase public awareness of freshwater biodiversity issues, encourage involvement in monitoring and restoration of local sites, and through this involvement, increase biodiversity values in these areas. Both sites are within the North-West Wildlink project area - Nukumea Stream (by Alice Eaves Scenic Reserve, Orewa) and Rothesay Bay Stream (Rothesay Bay). The project was successful in locating a new spawning site on the Rothesay Bay Stream, and engaging with local communities and schools.

The Local Board chose to continue with an extended project in 2018/19. An additional three sites were added to the project – Taiaotea Creek at Browns Bay, Stanmore Bay Stream and Awaruku Creek at Long Bay. The focus for existing sites was to continue monitoring, and implement some of the recommendations from the 2017/18 financial year. For the new sites, the focus was on investigating water quality, locating the saline wedge (the area where inanga are most likely to spawn), undertaking fish surveys and egg checks, and engaging with the local community.

This report details the results from the 2018/19 financial year and recommends further actions that could be taken at existing sites to protect and enhance them. It also recommends sites that could be included in the 2019/20 financial year, should the project continue.



Photo: Inanga (*Galaxias maculatus*)

Background

The Inanga Lifecycle

Inanga *Galaxias maculatus* are a freshwater fish from the *Galaxiidae* family and are widespread across much of the southern hemisphere. In New Zealand, they are most commonly known as 'whitebait', and make up approximately 90% of a whitebait catch. They are the smallest of the five whitebait species.

Inanga are migratory, meaning that they spend part of their time in freshwater and part in saltwater. They are poor climbers and so are often restricted to lowland rivers and streams because of barriers in waterways. Adults live in the freshwater environment but every autumn, they migrate in schools down to the saltwater interface (saline wedge), where freshwater meets the sea. Here, they wait until the highest Spring tide then wriggle into submerged vegetation at the top of the stream bank to lay their eggs (spawn). They prefer to lay their eggs in dense, rank grass or other vegetation that has a thick root mat and will retain moisture and protect the eggs from sunlight and predators. After spawning, most adults die.



Photo: Inanga eggs in dense root mat (Sophie Tweddle, WBC)

The eggs remain out of water for up to a month, until the next spring high tide inundates them with saltwater. The eggs then hatch, and the larvae are transported out to sea on the receding tide. The tiny inanga spend about 6 months out at sea, feeding on microscopic algae and zooplankton. In the spring, they school towards the shore, where they smell out the freshwater plumes from rivers and streams. Once in freshwater, they slowly make their way upstream to adult habitat. This is when they are caught as whitebait.

Inanga, like other freshwater fish species, have come under increasing pressure in the last 20 years, mainly from habitat loss. Latest estimates from NIWA indicate that this species is under threat and numbers are declining. Culverting of streams, channelization, installation of dams and weirs, grazing of riparian edges and mowing of river banks removes the habitat required to sustain this species. Introduced pest species, such as rats and mice, also have a huge impact on egg survival.



Photo: Instream barriers, such as perched culvert, can prevent inanga migration

Inanga are a hugely important part of the food chain, both in the marine and freshwater environment. Also, many things the inanga need – unrestricted access between rivers and the sea, good riparian vegetation, unpolluted water (cool, clean and clear), lack of introduced predators (rats, mice and hedgehogs) – are things that other freshwater and terrestrial species need to survive and flourish. If we can target these issues through protection, restoration and community engagement, it's a win for everyone.



Photo: Adult inanga caught in the Nukumea Stream

Inanga are a great tool for engaging people in their natural environment. A lot of people love whitebait fritters and don't want to see them disappear off our menus. It gives them reason to be involved in stream restoration and protection and make those connections between what lives in our natural environment and how our actions affect it.

Project Brief

The brief for the Hibiscus and Bays Local Board project is to:

- Increase awareness and action on the ground around the North-West Wildlink
- Build stronger relationships and networks across H&B community groups and individual landowners
- Take a landscape approach encompassing both public and private land to ensure integrated approach
- Freshwater and terrestrial biodiversity improvements
- Engage community and raise awareness around Inanga spawning and restoration

The results from the 2018/19 financial year follow. Results from each site are presented in separate chapters, with each chapter being a stand-alone report in itself. Results from the 2017/18 financial year can be viewed in the WBC report entitled, 'Hibiscus and Bays Inanga Spawning Project Report 2017/18'.

For the full survey methodology, please see Appendix 1. Raw data sheets and field survey results are available on request.

Individual Site Information

Rothesay Bay Stream

Site Description

Rothesay Bay Stream is a small, coastal stream that runs from Browns Bay Road to Masterton Road in Rothesay Bay. The upstream channel appears to be largely culverted, although there may be some small areas of open channel on private land. The open channel studied as part of this project begins just off Sandown Road, where it flows behind private property and into the Rothesay Bay Reserve.



Photo: Rothesay Bay Stream. Red dot indicates the study site. (Auckland Council GeoMaps)

The catchment is urban, comprising a mix of residential dwellings, gardens and roads. The stream runs through a reserve at the bottom of the catchment. Several stormwater pipes/outlets drain into the stream from the catchment.

The stream bottom is a mix of rock, gravel, sand and sediment, with some woody debris. There is relatively good in stream habitat however the water level upstream of the saline wedge is often very low. A search of the New Zealand Freshwater Fish database showed records for inanga, banded kōkopu and short fin eel in the stream. Water quality at the site is not monitored by Auckland Council.

Site Survey Results

This site was first monitored through this project in November 2017. Water quality samples were taken throughout the 2017/18 financial year. Water quality in the stream was found to be generally good, except for after heavy rainfall, when the stream is affected by stormwater and possibly greywater/sewage. The stream entrance is prone to becoming blocked by sand and this too was found to have an effect on water quality (stagnation).

Two fish surveys were also undertaken and the saline wedge was mapped. Artificial inanga spawning habitat was installed on the banks of the stream and egg surveys of this, and available natural habitat, were undertaken.

A small number of inanga eggs were found in clumps of *Carex*, downstream of the footbridge by the playground, on one occasion in 2018. This indicates that inanga are present in the stream and trying to spawn, however, there is very little natural habitat available for them to spawn in. What little habitat there is, is only available on a spring high tide, when the mouth of the stream isn't blocked by sand.

It is unlikely that the eggs found would have survived to hatch as the vegetation was too dry and exposed. Pest monitoring of the area around the stream also showed the presence of rats and mice, which are known to predate inanga eggs.

In the 2018/19 financial year, a further three water samples were taken from the stream. These were taken as part of quarterly water quality monitoring and do not take into account water quality after heavy rainfall. The results are summarised below:

Parameter	Results Range			Summary Grade (Good/OK/Poor)	Wai Care Guideline Values
	Highest	Median	Lowest		
Water Temp (°c)	20.7	18.6	16.3	Good	<21°c (good) >26°c (poor)
Water Clarity (cm)	79	71	43	Good	<30 (poor), >60 (good)
pH	7.5	7.5	7	Normal	Normal range 6 -8
Nitrate (mg/L)	5	1	>1	OK	>5 (poor)
Phosphorous (mg/L)	0.025	0.025	0.025	Good	>0.8 (Poor)
Dissolved Oxygen (mg/L)	8	6	4	OK	<4 (poor), >6 (good)
<i>E. coli</i>	800			Poor	>550 CFU/100ML (Poor)

Table: Water quality results, Rothesay Bay Stream

Fish surveys were undertaken on two occasions. Three Gee’s minnow traps were placed at various locations in the stream, above the saline wedge. Traps were set in the evening and checked the following morning. Fish caught or seen during these surveys can be seen in the table below.

Date of survey	Location of trap	Species Caught	Number	Conservation Status
09.11.18	Below bridge	Juvenile Galaxiid	1	Unknown
	Observed in stream	Short-fin eel	5	Not Threatened
	Observed in stream	Inanga	3	Declining
18.03.19	Below footbridge	Common bully	1	Not Threatened

Table: Fish survey results, Rothesay Bay Stream

Two egg searches were undertaken during the autumn of 2019, however, no inanga eggs were found this year. For the first part of the spawning season (March/April/May), the stream mouth was blocked by sand and the water level in the stream was not affected by tide. It is therefore unlikely that inanga would have been able to reach habitat at the top of the banks to spawn during this time. An egg search undertaken at the start of June, once the stream mouth had cleared, found no eggs.

It is hoped that planting undertaken in May 2019 will help to boost the amount of easily accessible habitat, at lower bank level in the stream, so that inanga are not so reliant on King tides, or the stream mouth being fully open, to spawn.

Education and Community Engagement

Total number of people directly engaged: 71

Number of native plants planted: 500

Length of riparian vegetation restored: 30m

Hibiscus and Bays Restoration Network

The Hibiscus and Bays Restoration Network brings together communities across the Hibiscus and Bays Local Board area to work on environmental restoration and enhancement projects in local reserves.

On the 4th May, volunteers from the local community joined WBC and Ben Sheeran for a planting day at Rothesay Bay Stream. The aim was to plant two areas of bank that are lower lying and currently have no vegetation cover, with the hope that inanga will use these areas to spawn. In the event, a further two areas of less-steep bank were also planted, potentially adding four new areas of available inanga spawning habitat. A total of 350 plants were planted.



Photo: Community volunteers get stuck into the planting

On the 30th May, the WBC Auckland team met at the site to plant an additional 30 salt-tolerant plants, and move some plants that looked to be struggling in the salt water to higher ground.



Photo: Finished bank planting at Rothesay Bay

Ben Sheeran from the local community group has been instrumental in getting action undertaken at this site. He has liaised with Council to get pest bait stations installed along the stream, and he liaised with the school to get help for the planting day. He also tackled the issue of pest planting on the reserve by a neighbour, and reached a compromise with the neighbour over new species to plant. He is an asset to the community, and to the reserve.

Browns Bay Pippins

On the 8th November, the Browns Bay Pippins ran a session at the stream with the WBC, to work towards their community badge. The Pippins analysed water samples, looked for stream life, checked fish traps and then collected rubbish from the reserve and beach. A great evening was had by all!

Browns Bay School

On the 6th June, a year 5 class from Browns Bay School walked to the site to help WBC and Ben Sheeran with a streamside planting. The planting was to replace weed species that were recently cleared from the top of the bank, behind 49 Masterton Road. A total of 120 plants were planted with the help of the students, despite some heavy downpours.

The school have been very supportive of both this project, and the project on the Taiatotea Creek. It would be great to support a full programme with the school again in 2019/20.



Photo: Browns Bay School planting at top of bank, Rothesay Bay Stream

Recommendations for 2019/20

Rothesay Bay Stream is a valuable freshwater asset in the local area, despite the channel being highly modified and impacted by stormwater runoff. Fish do still survive in the stream and if the community continue to care for the stream and its surrounds by weeding, in-fill planting and rubbish collection, the stream will hopefully continue to support freshwater and terrestrial biodiversity.

Further recommendations for the site include:

- Continuing to support the community at weeding bees and stream events
- Continuing to support pest control at the site where we can
- Continuing to work with schools in the local area through a stormwater education programme, with the aim of reducing litter in the environment
- Continuing to monitor the stream for spawning activity during the spawning season, to evaluate the success of the stream planting

Nukumea Stream

Site Description

The Nukumea Stream is located at the northern end of Orewa. It is one of the last, largely natural streams in the Auckland Region and has high biodiversity values. The stream was chosen by NIWA for release of giant kōkopu (another whitebait species) in 2009 and again in 2019, due to its natural state and good instream habitat.



Photo: Nukumea stream catchment. Red dot indicates study site. (Auckland Council GeoMaps)

The upper catchment of the stream (west of State Highway 1) is largely forested (Nukumea Scenic Reserve). The catchment east of SH1, is bordered by a large area of privately owned, native bush, and Alice Eaves Scenic Reserve on the true left bank. The true right bank is bordered by new development and residential areas. Much of the new development is in close proximity to the stream.

Riparian vegetation upstream of the Kensington Park footbridge is largely native bush however there is an area of disturbed, weedy habitat adjacent to the new development, by the saline wedge.

Downstream of the footbridge, riparian habitat is native bush on the true left bank and grass/lawn on the true right.

The stream bed is largely soft-bottomed. There is an area of exposed bedrock by the bridge in Kensington Park, and there are some small areas of boulder/woody debris. All in-stream habitat is covered in a fine layer of clay sediment. Where there is no exposed bedrock on the stream bed, the

sediment, particularly by the saline wedge, is deep and easily disturbed. There has been a noticeable increase in sediment in the stream, and on riparian vegetation, in the last year.



Photo: Sediment deposition on the stream banks and on in-stream vegetation



Photo: Sediment in the stream after rainfall, on two different occasions.

Historically, inanga, banded kōkopu, giant kōkopu, common, giant and redfin bully and short and long-fin eel have been caught in the stream.

Site Survey Results

This site was first monitored through the project in November 2017. Water quality samples were taken throughout the 2017/18 financial year, three fish surveys were undertaken and the saline wedge was mapped. In addition, artificial spawning habitat was installed on the banks of the stream and egg surveys of this, and available natural habitat, were undertaken. Pest monitoring of the area around the stream showed the presence of rats, mice and hedgehogs – all natural predators of inanga eggs.

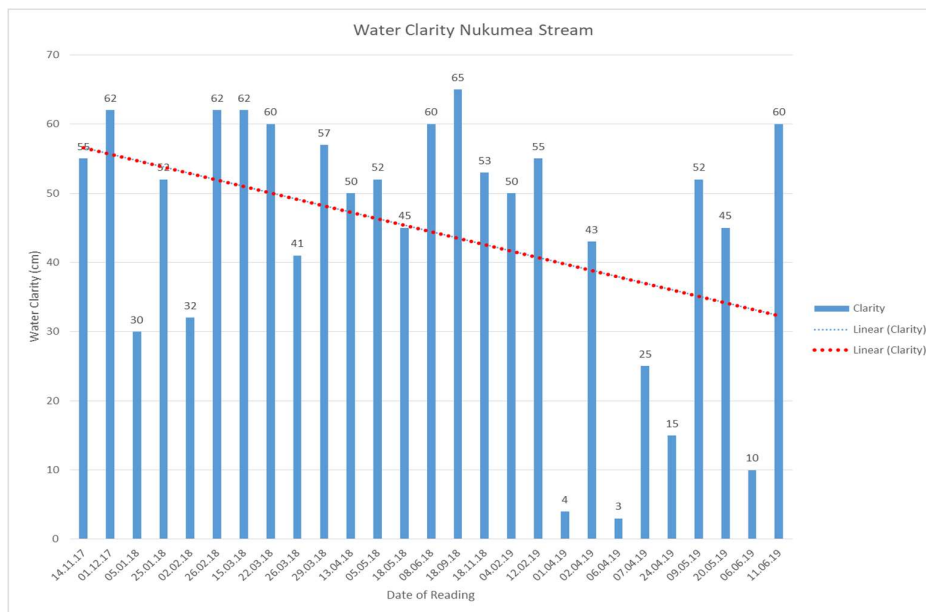
Despite finding the saline wedge and an abundance of inanga in the stream, no spawning activity was observed during the autumn of 2018, and no eggs were found. Survey conclusions were that although water quality in the stream was generally good, the stream was affected by high sediment loads during rainfall events, which could affect inanga. There was also found to be a lack of suitable, natural riparian vegetation for inanga to spawn in, and dogs were rapidly destroying what little habitat was available. The presence of pest species could also be a factor in egg survival.

In the 2018/19 financial year, a further thirteen water samples were taken from the stream. Some of these were taken as part of routine testing, others were taken after heavy rainfall events. The results are summarised below:

Parameter	Results Range			Summary Grade (Good/OK/Poor)	Wai Care Guideline Values
	Highest	Median	Lowest		
Water Temp (°c)	20	14	11.1	Good	<21°c (good) >26°c (poor)
Water Clarity (cm)	65	45	3	OK, declining	<30 (poor), >60 (good)
pH	7.5	7	7	Normal	Normal range 6 -8
Nitrate (mg/L)	1.5	>1	>1	Good	>5.0 (poor)
Phosphorous (mg/L)	0.6	0.025	>0.025	OK	>0.8 (poor)
Dissolved Oxygen (mg/L)	9	7	6.5	Good	<4 (poor), >6 (good)

Table: Water quality results, Nukumea Stream

The most interesting results for the year have been those for water clarity. Previously, clarity was only measured as part of regular monitoring (not in response to rainfall). Observations and photos taken by concerned residents did, however, show that clarity was greatly affected by rain. In 2019, volunteers managed to take samples during or directly after heavy rainfall events and the results show how heavily impacted the stream is by sediment. In total, 10 incidents of heavy sediment in the stream have been recorded in the last 18 months.



Graph: Water clarity measurements on the Nukumea Stream over a 19 month period

The Wai Care guidelines for clarity indicate that a measurement greater than 60cm is good, a measurement between 30 and 60cm is ok and a measurement below 30cm is poor. High levels of sediment can clog the gills of fish and macroinvertebrates, interfere with predator/prey relationships due to poor visibility and cover in-stream and riparian habitat, reducing the amount of habitat available for fish and bugs to use. Sediment deposition at inanga spawning sites during the spawning season can also smother and kill inanga eggs.

On two occasions, clarity in the stream dropped below 5cm. Clarity dropped below 30cm on another three occasions. This increase in sediment in the stream has impacted instream and riparian habitat, by smothering vegetation and infilling gaps between rocks and stones.

Fish surveys were undertaken on two occasions in 2018/19. Six Gee’s minnow traps and two Fyke nets were placed above and at the saline wedge. Traps were set in the evening and checked the following morning, with the help of volunteers.

At the start of the project (Spring 2018), inanga were caught in nets and regularly seen in large shoals in the stream. By the end of the financial year, no inanga were seen in the stream and only one adult was caught in May 2019. It is possible that the fish have left the stream, or perished, due to high sediment loads in the stream however this cannot be proven. Results from fish surveys and casual observations can be seen in the table below.

Date of survey	Location of trap	Species Caught	Number	Conservation Status
18.11.19	Upstream, in bush	Giant bully	1	Naturally uncommon
		Common bully	4	Not threatened
		Redfin bully	1	Not threatened
		Inanga	2	Declining
12.02.19	Upstream of wedge	Inanga	Shoal x 2	Declining
07.05.19	Upstream, in bush	Giant kōkopu	24	Declining
		Long-fin eel	1	Declining
		Inanga	1	Declining
		Redfin bully	3	Not threatened
		Common bully	4	Not threatened
		Giant bully	1	Naturally uncommon
		Banded kōkopu	1	Not threatened

Table: Fish survey results, Nukumea Stream (species in bold are whitebait species)

No spawning surveys or egg checks were undertaken in the 2018/19 financial year as few inanga were observed in the stream prior to, or during the spawning season, and the limited riparian habitat available for spawning was damaged during the storm events of 1st April and 6th April 2019. Significant quantities of sediment were deposited on plant stems and bases, making the habitat unsuitable for egg laying or egg survival.

Education and Community Engagement

Total number of people directly engaged: 49 people

Number of native plants planted: 100

Length of riparian habitat restored: 20

Nukumea Stream Volunteers/Wai Care

A group of five volunteers have been helping monitor water quality, undertake pest trapping and check fish traps for the last two years on the Nukumea Stream. The group has changed in number however a core group of three volunteers continue to regularly monitor and lay bait.

David and Adrienne Wright have been instrumental in undertaking pest trapping, recording episodes of sedimentation and helping with fish surveys. Adrienne also designed a leaflet for the stream, explaining its value and trying to encourage people to look after it. These leaflets were made available in a leaflet holder, attached to the inanga spawning sign erected at the saline wedge.



Photo: The Nukumea Stream volunteers help to check fish traps and measure fish, November 2018

NIWA

In March 2019, NIWA asked WBC and the Nukumea Stream volunteers to help with the release of 1000 giant kōkopu into the stream. A previous pilot study conducted in 2009 showed that the fish could survive in the stream and so a larger scale release was planned, to help boost numbers.

Juvenile giant kōkopu (in the form of whitebait) are only attracted to a stream if they can smell pheromones released by an adult and so it is essential to have a healthy population of adults in order to encourage the replenishment of the stream.

A total of 12 people were involved in the release and it went very smoothly. A follow-up fish survey conducted by WBC and the Nukumea volunteers in May caught 24 giant kōkopu, one of which was not captive breed, indicating that there is a small, established population in the stream. The fish seemed to be in good health, despite recent high sediment loads in the stream. The fish are not tagged and therefore follow-up monitoring will involve biannual fish trapping to monitor survival rates and fish growth. WBC will assist with this survey work.



Photo: Giant kōkopu release and two giant kōkopu caught in the stream on the 7th May 2019

Orewa Primary School

Orewa Primary participated in a full WBC programme in 2018, and expressed an interest in continuing to be involved in the project in 2019. The school runs an Environment Club on Mondays after school. In Term 2 2019, WBC worked with this group to learn more about the Nukumea Stream, and come up with an action plan to help engage more people with the stream.

The students visited the stream and helped to test water quality, assess habitat and check for stream life. They then designed some posters to be made into signs to go next to the stream. The posters encourage people to keep their dogs on a lead and to help look after the stream by not dropping rubbish. Unfortunately, the Reserve has since been closed due to Kauri Dieback and so the signs have yet to be installed.



Photo: Orewa Primary students play 'pin the tail on the inanga' and inanga and ladders

Pacific Heights Development

In May, the Local Board arranged for WBC to meet with Auckland Council and representatives from the Pacific Heights development, which is adjacent to the Nukumea Stream, upstream of the project site. The meeting was to discuss ways to work together to improve water quality in the Nukumea Stream, following several recent sediment discharges into the stream from the site.

The developers explained what they were doing to improve sediment control features on site and invited WBC to have a stand at their site open day, to help educate potential buyers about the importance of the stream. At the event, WBC engaged with people and helped to spread the message about the importance of our waterways.

Pacific Heights have offered to donate native plants to help restore areas of riparian vegetation in the stream that were damaged by sediment in April 2019. WBC has also offered to provide the Pacific Heights team with some training in how to identify important stream habitats and stream life.

Recommendations for 2019/20

The Nukumea Stream remains a highly important freshwater system in the Auckland region, despite the impact that large-scale development has had on water quality and in-stream habitat. The channel is largely natural, there are few in-stream barriers and the large area of native bush in the upstream catchment provides a source of clean water, and macroinvertebrates, as well as undisturbed habitat for fish.

It is great that the local community is increasingly involved in preservation and restoration of the stream. Community engagement helps to support long-term protection of streams in urban areas, and volunteer participation in planting, monitoring and pest trapping allows for these activities to be undertaken, where financial resources are limited.

However, the work undertaken to date will have no impact on inanga spawning success in the stream if the issue of high sediment loads in the stream is not resolved.

Recommendations for the site include:

- Continuing to support volunteers to monitor water quality and to undertake pest trapping along the stream
- Continuing to use the stream as an 'outdoor classroom' for schools in the local area
- Working with Auckland Council to investigate sources of sediment in the stream and to discuss possible ways of stabilising banks
- Working with NIWA to monitor giant kōkopu populations in the stream
- Providing training to the development team at Pacific Heights, so that they can identify important stream habitats and help protect them in future developments
- Organise a community education event (either spotlighting evening, or presentation) to help raise the profile of the inanga spawning project, and further engage people in Orewa.

Awaruku Creek

Site Description

Awaruku Creek is a small, coastal stream that runs from the top of Glenvar Road, through Torbay and out into the Hauraki Gulf at Long Bay. The stream is largely open (not culverted) but there are some sections that have been culverted and channelized.



Photo: Awaruku Creek at the stormwater ponds. Red dot indicates study site. (Auckland Council GeoMaps)

The catchment is urban, comprising a mix of residential dwellings, gardens, reserves and roads. The stream runs through several reserves at the top and middle of the catchment, and a large stormwater pond/wetland at the bottom of the catchment. Several stormwater pipes/outlets drain into the stream from the catchment.



Photo: Awaruku Creek at the saline wedge – upstream (left) and downstream (right)

The stream is gravel-bottomed with good instream habitat and short, medium thickness riparian vegetation. A search of the New Zealand Freshwater Fish database showed historic records of inanga and banded kōkopu, as well as common bullies, red finned bullies, *Gambusia* (mosquito fish), short and long-fin eels, estuarine triplefins and common smelt.

Water quality at the site has not been monitored historically, however, 10-years of water quality data exists for a site further upstream, at 30 Glenvar Road.

Site Survey Results

Water quality testing was undertaken on five occasions to get baseline information for this site. The results are summarised below:

Parameter	Results Range			Summary Grade (Good/OK/Poor)	Wai Care Guideline Values
	Highest	Median	Lowest		
Water Temp (°c)	22.5	19	14	OK	<21°c (good) >26°c (poor)
Water Clarity (cm)	75	70	63.5	Good	<30 (poor), >60 (good)
pH	7	7	7	Good	Normal range 6 -8
Nitrate (mg/L)	1	0	0	Good	>5 poor
Phosphorous (mg/L)	0.1	0.05	0.025	OK	>0.8 poor
Dissolved Oxygen (mg/L)	9	6	6	Good	<4 (poor), >6 (good)

Table: Water quality test results, Awaruku Creek

Fish surveys were conducted on four occasions. Traps were placed at various locations within the stream by the saline wedge (see map below for numbering). Traps were set in the evening and checked the following morning.

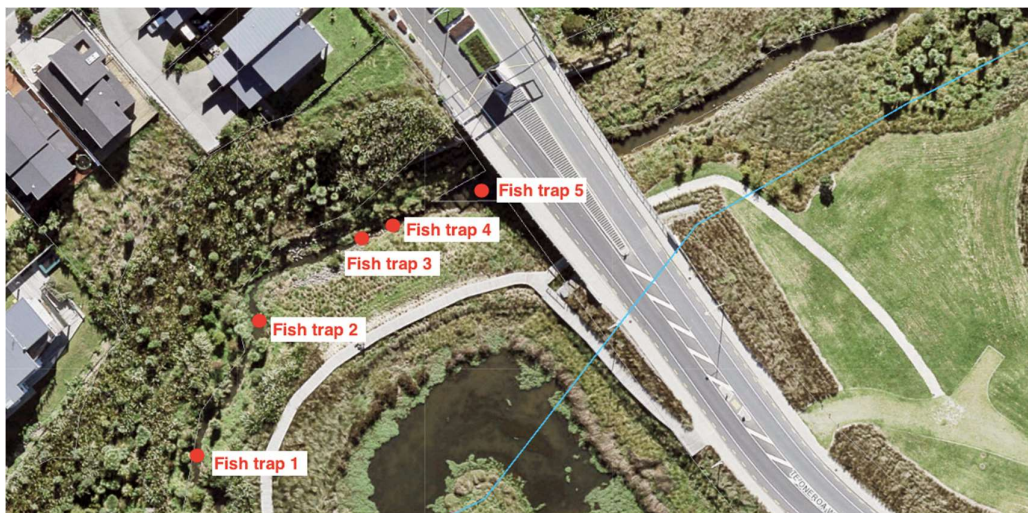


Photo: Location of fish traps at Awaruku Creek (Auckland Council GeoMaps)

Results from these surveys can be seen in the table below. Only traps which recorded a result are listed. Traps not present in the table recorded a zero result (no fish caught).

Date of survey	Location of trap	Species Caught	Number	Conservation Status
18.12.2019	Fish trap 3	<i>Gambusia affinis</i>	14	Invasive, naturalised
18.12.2019	Fish trap 1	Common bully <i>Gambusia affinis</i>	2 5	Not Threatened Invasive, naturalised
18.02.2019	Fish trap 4	<i>Gambusia affinis</i>	20	Invasive, naturalised
18.02.2019	Fish trap 5	<i>Gambusia affinis</i>	11	Invasive, naturalised
18.02.2019	Fish trap 2	Common bully	3	Not Threatened
01.05.2019	Fish trap 4	Inanga	10	Declining
01.05.2019	Fish trap 3	Redfin bully Inanga	1 3	Near Threatened Declining
12.06.2019	Fish trap 1	Common bully	1	Not Threatened
12.06.2019	Fish trap 3	<i>Gambusia affinis</i>	2	Invasive, naturalised

Table: Fish survey results, Awaruku Creek

Whitebait Connection also undertook a saline wedge survey of the stream, and an assessment of habitat around the saline wedge, to check the sites suitability for inanga spawning. The saline wedge was found at NZTM 1756093, 5938051 on the 26.11.2019. Flow conditions were low.



Photo: saline wedge on the Awaruku Creek (Auckland Council GeoMaps)

A small area of suitable habitat was found at the saline wedge however, as this habitat was limited, artificial habitat was installed at the site.



Photo: Awaruku Creek hay bale installation

Three spawning surveys and egg checks were undertaken at suitable locations on the stream during the spawning season. Eggs were found during two of the three surveys, however no spawning activity was seen.

The map below shows the location of eggs. Eggs were found in both the hay bales and the natural habitat surrounding the hay bales.



Photo: Location of inanga eggs on the Awaruku Creek



Photo: Inanga eggs found in natural habitat surrounding the hay bales

Education and Community Engagement

Total number of people directly engaged: 102 people

Spawning confirmed: Yes

Sir Peter Blake Marine Education and Recreation Centre (MERC)

WBC, through the Auckland Council Wai Care programme, helped to train MERC in the use of the Wai Care water testing kit. Staff members from MERC then helped WBC test the water quality at this site throughout the spawning season. MERC now have their own Wai Care kit and have committed to testing water quality on the stream long term, as part of their education programme, however this is dependent on schools wanting to be involved.

MERC have also been assisting with egg searches and spawning surveys. They are keen to get involved with pest monitoring at the site as well as contributing to the Awaruku Stream mural.

Friends of Long Bay and Torbay Enviro Group

Friends of Long Bay and Torbay enviro group joined WBC for an egg search, water testing and pest monitoring.



Photo: Torbay Enviro group looking for inanga eggs

They are keen to contribute to the Awaruku Creek mural. They have contacts at Rotary and Men's Shed who may be able to help in the construction of a mural as they have woodworking skills to lend. The group will join WBC for another egg search and water testing session on the 23rd June. Creation of a mural to go alongside the stream will be in term 3 and is the action project decided upon by Long Bay Primary.

This community group already does pest monitoring, baiting and trapping around the wetland area and are keen to extend this to the spawning area on the creek.

Long Bay Primary School

Long Bay Primary are participating in a full Whitebait Connection education programme, with a focus on the inanga spawning project. A total of 80 year 1/2 students are involved in the programme.

WBC have delivered two classroom sessions (an introduction to freshwater and field trip preparation), in addition to a field trip, where students measured water quality, assessed inanga spawning habitat and looked at stream life.

A further classroom session is booked for the 18th June and a second field trip on the 21st June, which will involve students helping with pest monitoring, egg searching and learning about storm water pollution.

For the school's action project, the students are going to design and create a stream-side mural, depicting what they have learnt about their stream. This will help engage the public and raise awareness of the importance of the stream.



Photo: Long Bay Primary students completing a whitebait puzzle (left) and searching for stream life (right)



Photo: Long Bay Primary students learn about Fyke nets and record their water testing results

Torbay School

Torbay School have expressed an interest in being involved in a full education programme on the creek in Term 3 or 4 2019, and are keen to assist with further survey and restoration work moving into the whitebait season.

Conclusions and Recommendations for 2019/20

Awaruku Creek is an important freshwater habitat in the local area and is home to several declining species, including inanga and long-fin eel. Upstream in Awaruku, there are several mature, bush reserves where the stream still supports a diverse range of stream species and a more natural riparian habitat. In the lower reaches of the stream, however, recent high-density housing development has greatly affected the stream channel and riparian habitat.

This stream feeds into the Long Bay Marine Reserve and is part of Long Bay Regional Park and thus stream water quality directly impacts the biodiversity and health of these unique environments. Engaging the local community is therefore essential in order to prevent further degradation of the creek, and stormwater pollution reaching the sea.

Potential inanga spawning habitat at the saline wedge is limited. The habitat that is present is of good quality but due to the rocky nature of the majority of the bank, this habitat is limited to 7m on

the true left side of the bank. This area should be protected from further disturbance and could be enhanced with appropriate planting.

Auckland Council, Healthy Waters currently plans to undertake erosion prevention work 15m upstream of the inanga spawning site. It is recommended that WBC liaise with Healthy Waters over this work, to ensure that the spawning site is not damaged.

Results from pest monitoring show that the hay bale site is visited by a high abundance of mice and rats. There is wider pest monitoring and baiting being conducted by local community groups in the wetland area and there is potential to expand and intensify this near the spawning site during spawning season.

Recommendations for this site include:

- WBC working with Auckland Council Healthy Waters and Morphem Environmental to limit the impact of the proposed upstream erosion prevention work on the spawning site
- Working with local community group to intensify trapping of pest species around the spawning site during spawning season
- Supporting creation of a mural by Long Bay Primary, Torbay enviro group and Friends of Long Bay, to engage the larger community with the stream
- Continuing to work with schools in the local area through a stormwater education programme, with the aim of reducing the impacts of storm water pollution
- Working with MERC to expand awareness of inanga and the importance of spawning sites to visiting schools from around Auckland
- Continuing to monitor the stream for water quality and spawning activity

Stanmore Bay Stream

Site Description

Stanmore Bay Stream is a small, coastal stream consisting of two main branches. The southern branch runs from residential development to the south of Whangaparaoa Road, through Stanmore Bay Park and out into Stanmore Bay at the southern end of the beach.

The northern branch runs from residential development in the north of Stanmore Bay, through D'Oyly Weir Reserve and into Stanmore Bay Road reserve, where it meets the southern branch.

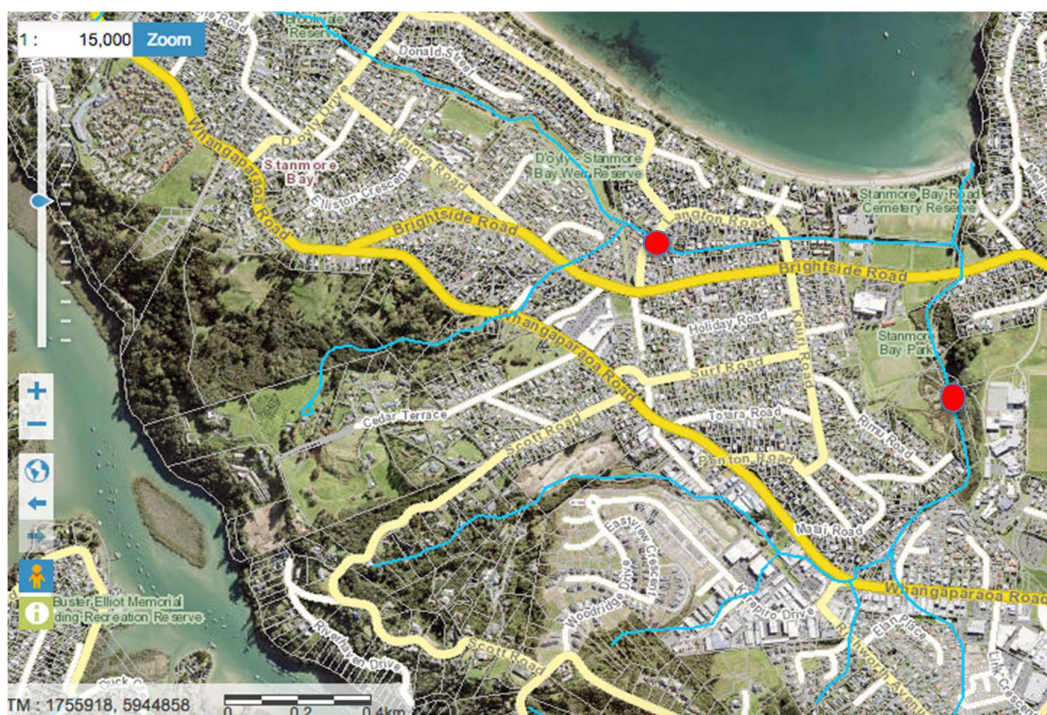


Photo: Stanmore Bay Stream. Red dots indicate survey sites. (Auckland Council GeoMaps)

The catchment is largely urban, comprising a mix of residential dwellings, gardens, industrial areas and roads. Both branches of the stream run through smaller areas of reserve but the channel is highly modified. Several stormwater pipes/outlets drain into the stream from the catchment and there are large stormwater ponds on the southern branch.

The stream is soft bottomed with reasonable instream habitat on both branches and areas of good riparian habitat within the reserves. A long stretch of the northern branch has recently been naturalised, which has added to its ecological value.



Photo: Riparian habitat along the southern branch, close to the saline wedge

A search of the New Zealand Freshwater Fish database showed no historic fish records for this stream and previous fish surveys have found only *Gambusia affinis* (mosquito fish). Water quality in the stream is not monitored by Auckland Council.

Site Survey Results

Water quality testing was undertaken on four occasions on the southern branch, to get baseline information for this site. The results are summarised below:

Parameter	Results Range			Summary Grade (Good/OK/Poor)	Wai Care Guideline Values
	Highest	Median	Lowest		
Water Temp (°c)	20	18.55	15.6	Good	<21°c (good) >26°c (poor)
Water Clarity (cm)	75	58	35	OK	<30 (poor), >60 (good)
pH	7.5	7.5	7	Normal	Normal range 6 -8
Nitrate (mg/L)	2	1	1	OK	>5 (poor)
Phosphorous (mg/L)	0.05	0.025	>0.025	Good	>0.8 (poor)
Dissolved Oxygen (mg/L)	6.1	4	3.5	OK	<4 (poor), >6 (good)

Table: Water quality results, Stanmore bay

Fish surveys were undertaken on five occasions. Traps were placed at various locations on the southern branch and at one site on the northern branch (see map below for numbering). Traps were set in the evening and checked the following morning.



Photo: Location of fish traps on Stanmore Bay stream (Auckland Council GeoMaps)

Results from these surveys can be seen in the table below. Only traps which recorded a result are listed. Traps not present in the table recorded a zero result (no fish caught).

Date of survey	Location of trap	Species Caught	Number	Conservation Status
12/11/19	B	<i>Gambusia affinis</i>	50+	Invasive/naturalised
	C	<i>Gambusia affinis</i>	50+	Invasive/naturalised
26/03/19	A	Inanga	10	Declining
	B	<i>Gambusia affinis</i>	50+	Invasive/naturalised
	C	<i>Gambusia affinis</i>	50+	Invasive/naturalised
24/04/19	A (observed not trapped)	Inanga	6	Declining
	A	<i>Gambusia affinis</i>	20+	Invasive/naturalised
	B	<i>Gambusia affinis</i>	50+	Invasive/naturalised
	E	Inanga	1	Declining
14/05/19	C	<i>Gambusia affinis</i>	50+	Invasive/naturalised
	D	Shortfin eel	2	Not threatened
	E	Redfin Bully		Not threatened
	E	Giant Bully	7	Naturally uncommon
	E	Inanga	2	Declining
02/06/19	C	<i>Gambusia affinis</i>	10	Invasive/naturalised
	D	<i>Gambusia affinis</i>	3	Invasive/naturalised
	E	Giant Bully	1	Naturally uncommon
	G	<i>Gambusia affinis</i>	20+	Invasive/naturalised
	H	<i>Gambusia affinis</i>	20+	Invasive/naturalised

Table: Fish survey results, Stanmore Bay



Photo: Giant bully, inanga (far left) and Gambusia (top middle) caught in the southern branch

WBC also undertook a saline wedge survey of the stream, and an assessment of habitat around the saline wedge, to check the sites suitability for inanga spawning.

The saline wedge was found at Point A (NZTM 1755111, 5945192) on the northern branch and Point B (NZTM 175859, 5944853) on the southern branch on the 12/11/19. Flow conditions were low. The habitat was found to be suitable for inanga to spawn on the southern branch but vegetation cover was limited on the northern branch.

A further saline wedge survey was undertaken on the southern branch after low tide observations at point B of crab holes. On this occasion, the wedge was found to be further upstream at Point C. Habitat at this point is marginal. The banks of the stream are steeper and it is not clear if a spring high tide would inundate vegetation at the top of the bank.



Photo: Location of saline wedge on both branches of Stanmore Bay

Unfortunately, despite finding inanga on both tributaries of the stream, no spawning activity has been observed to date and no eggs have been found on either branch. It may be worth installing artificial habitat on the stream in 2020, to confirm whether or not inanga would spawn if suitable habitat was present. If spawning is confirmed, WBC can then work with landowners to plant riparian vegetation that is suitable for inanga to spawn. It may also be possible to create some inanga 'benches' on the southern branch, in collaboration with Healthy Waters.

Education and Community Engagement

Total number of people directly engaged: 45

Spawning confirmed: No

Wentworth College

WBC have been delivering a stormwater education programme to Wentworth College in Term 2, with the focus being on Stanmore Bay Stream. In total, 39 Year 8 students have participated in classroom sessions and a field trip. The students are currently formulating an action plan to raise public awareness about stormwater pollution.



Photo: Students from Wentworth College look for stream life

Stanmore Bay Kindergarten

Stanmore Bay kindergarten participated in the Ko Te Wai Ha Taonga Programme in Term 2 2019 and have expressed an interest in continuing to work with the WBC, helping to look after Stanmore Bay stream in D'oyly Reserve. The staff, parents and children are keen to visit the stream to test water quality and look for stream life, and have already undertaken litter pickups in the area. WBC could work with this centre in Term 3 or 4 2019.

Private Landowner, 7 Langdon Road

On the northern branch of the stream, the landowner at 7 Langdon Road was contacted to arrange permission to access the stream behind their property. They are keen to see the land around the stream managed to avoid overgrowth of weeds and have requested help with planting the stream bank. The saline wedge was located at this site, along with several gravid inanga later in the season.



Photo: Location of saline wedge behind property at 7 Langton Road

Recommendations for 2019/20

Stanmore Bay Stream is an important freshwater resource on the Whangaparaoa Peninsula as it is one of the few remaining streams that has not been culverted. This also makes it one of the few streams in the area where inanga could spawn.

However, issues with the stream include poor water quality after rainfall due to stormwater runoff, high water temperature and low dissolved oxygen during the summer months due to low water levels and lack of taller, shade species, and the abundance of the aggressive pest fish, *Gambusia*, in the stream.

Both branches have areas that could be used by inanga to spawn, however, no spawning activity or eggs were during the 2019 spawning season. Areas of suitable habitat around the saline wedge should, however, be protected and enhanced, as these are the most likely areas for spawning to occur.

Recommendations for the site include:

- Working with Auckland Council Healthy Waters to improve water quality and in-stream habitat in the southern branch
- Working with the landowner on the northern branch to plant and protect the stream at this location
- Clearing upstream areas on the northern branch of invasive oxygen weed
- Clearing upstream areas of instream vegetation on southern branch, to improve flow and fish passage
- Undertaking pest control at both sites, particularly during the spawning season
- Continuing to work with schools in the local area through a stormwater education programme, with the aim of reducing litter and engaging more people in stream protection
- Working with Stanmore Bay Kindergarten to monitor the upstream habitat on the northern branch, and to collect rubbish
- Continuing to monitor stream water quality
- Installing artificial spawning habitat on the stream for the 2020 spawning season and encouraging the local community to help us monitor the site – further community engagement

Taiaoatea Creek, Browns Bay

Site Description

The Taiaoatea Creek is a small, coastal stream that runs from East Coast Road in the west, through residential development and out into the Hauraki Gulf at Browns Bay. The stream is stormwater fed and the upstream channel has been highly modified and culverted. A project is currently underway to open-up (daylight) and restore part of the stream that runs through Sherwood reserve to a more natural channel.



Photo: Taiaoatea Creek at Sherwood Reserve and Freyberg Park. Red dot indicates study site. (Auckland Council GeoMaps)

The catchment is urban, comprising a mix of residential dwellings, gardens and roads. The stream runs through several reserves at the bottom of the catchment – Sherwood Reserve, Freyberg Park and Browns Bay Creek Reserve. Several stormwater pipes/outlets drain into the stream from the catchment.

The stream is bedrock based below the limit of saltwater intrusion and soft bottomed upstream of the tennis courts in Freyberg Park. Riparian cover is patchy but there are small stretches of native vegetation within the reserves. There is limited instream habitat downstream of the saltwater limit but reasonable instream habitat within the freshwater.



Photo: Downstream (left) and upstream (right) view of Taiaotea Creek, Freyberg Park

A search of the New Zealand Freshwater Fish database showed historic records for inanga, banded kōkopu, long-fin eels and *Gambusia* in this stream. Water quality is monitored by Auckland Council at a permanent site within Freyberg Park.

Site Survey Results

Water quality testing was undertaken on five occasions to get baseline information for this project. The results are summarised below:

Parameter	Results Range			Summary Grade (Good/OK/Poor)	Wai Care Guideline Values
	Highest	Median	Lowest		
Water Temp (°c)	20.5	18	14.5	Good	<21°c (good) >26°c (poor)
Water Clarity (cm)	68	45	41	OK	<30 (poor), >60 (good)
pH	8	7	7	Normal	Normal range 6 -8
Nitrate (mg/L)	1	>1	>1	Good	>5 (poor)
Phosphorous (mg/L)	0.2	0.025	>0.025	Good	>0.8 (poor)
Dissolved Oxygen (mg/L)	7	7	4	Good	<4 (poor), >6 (good)
<i>E. coli</i>	800	-	-	Poor	>550 CFU/100ML (Poor)

Table: Water quality results, Taiaotea Creek

Fish surveys were undertaken on two occasions. Traps were placed at various locations around the saltwater limit (see map below for numbering). Traps were set in the evening and checked the following morning.

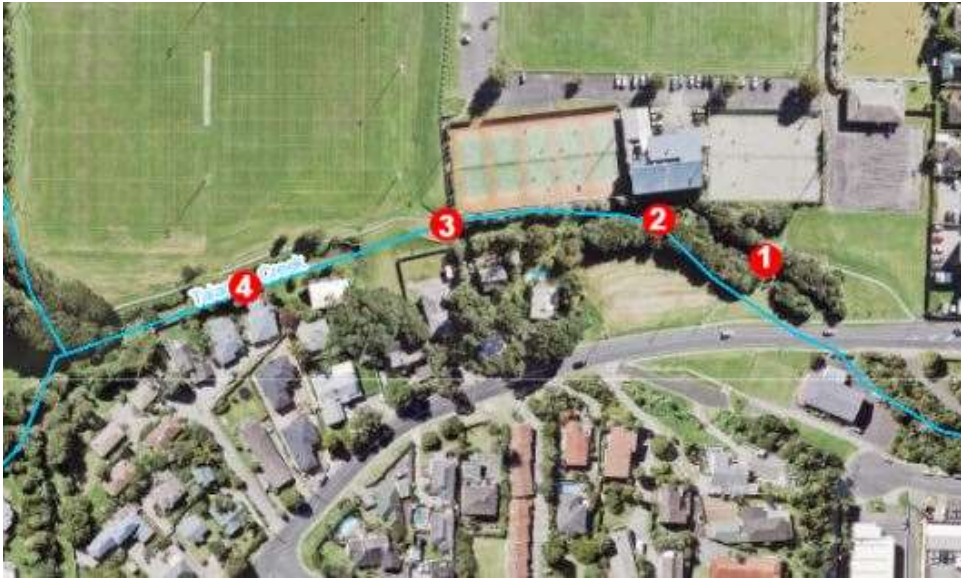


Photo: Fish traps Taiiaotea Creek (Auckland Council GeoMaps)

Results from these surveys can be seen in the table below. Only traps which recorded a result are listed. Traps not present in the table recorded a zero result (no fish caught).

Date of survey	Location of trap	Species Caught	Number	Conservation Status
11.11.18	1	<i>Gambusia affinis</i>	6	Invasive, Naturalised
11.11.18	2	Common Bully	1	Not threatened
		Female inanga	1	Declining
11.11.8	3	Inanga	1	Declining
		Short-fin eel	2	Not threatened
11.11.18	4	Short-fin eel	3	Not threatened
		Inanga	1	Declining
		<i>Gambusia affinis</i>	20	Invasive, Naturalised
25.02.19	2	Inanga	3	Declining
		<i>Gambusia affinis</i>	8	Invasive, Naturalised

Table: Fish survey results, Taiiaotea Creek

WBC also undertook a saline wedge survey of the stream, and an assessment of habitat around the saline wedge, to check the sites suitability for inanga spawning.

The saline wedge was found at NZTM 1755505, 5935186 on the 11.11.18. Flow conditions were normal at the time of survey. The habitat was found to be suitable for inanga to spawn around and upstream of the wedge, with dense, grassy habitat on the true right bank (looking downstream). There is, however, no suitable habitat on the true left bank as the bank has been retained with wooden boards.



Photo: Saline wedge (red dot) on the Taiāotea Creek and inanga caught during survey on 11.11.18 (diamond)

Two spawning surveys and egg checks were undertaken at suitable locations on the stream during the spawning season. No eggs or spawning was found on the 14.05.19. A small clump of eggs was, however, found on the 30.05.19. The map below shows the location of the spawning site.



Photo: Location of inanga spawning site on the Taiāotea Creek (Auckland Council GeoMaps)

Education and Community Engagement

Total number of people directly engaged: 217

Spawning confirmed: Yes

Hibiscus and Bays Restoration Network

WBC supported the Hibiscus and Bays Restoration Network at two community events during the 2018/19 financial year. The first event was a planting day at Browns Bay Creek/Clyde Road Reserve, where WBC assisted with tree planting and then collected some water and macroinvertebrate samples for people to view. WBC also gave a talk about the inanga spawning project, and what it aims to achieve.

The second event was a weeding bee. WBC assisted with weeding and also took small groups down to the water, to take water and macroinvertebrate samples. A total of 40 people attended the first event and 24 the second event.



Photo: Planting day on the Taiāotea Creek

Sustainable Schools

WBC assisted with the Browns Bay School Hikoi, run by Sustainable Schools and Healthy Waters, in February 2019. WBC gathered macroinvertebrate and fish samples from the stream to show the students. The students were given an introductory talk on freshwater life and what it can tell us about the health of a stream. They were then challenged with identifying macroinvertebrates, using

the Wai Care field guides. Following this, they were introduced to an inanga caught in the stream and told about the inanga life cycle, and the inanga spawning project.

Browns Bay Keas

The Brown Bays Keas group visited the stream in February 2019 to work towards their environment badge. A total of 15 keas and six adult helpers used simple equipment to test water quality. They then walked a short length of the stream looking for litter or other pollutants. They then took it in turns to 'fish' for macroinvertebrates in the stream, and to look for inanga.



Photo: Browns Bay Keas testing water quality at the Taiatea Creek

Conclusions and Recommendations for 2019/20

The Taiatea Creek is of high ecological value in the Bays District as it is one of the few remaining streams that still retains some good in-stream and riparian habitat for freshwater species. The water quality is, in general, good although the stream is affected by stormwater runoff.

As a high proportion of the downstream channel runs through reserves, it would be relatively easy to create a long-term restoration plan for the stream, outside of the work currently being undertaken within Sherwood Reserve. Inanga do have suitable spawning habitat available above the saline wedge, which they are using to spawn, however this needs to be protected from stream/channel clearance, or overgrowth by taller vegetation.

Results from pest monitoring show that rats and mice are present at the site. It would be great to introduce some pest trapping at the site, particularly during the spawning season. This would help to protect eggs from predation whilst they are developing in the riparian vegetation.

The site is ideal as an 'outdoor classroom' as it is relatively safe and easy to access. It is clear that Browns Bay School, and the wider local community, are very keen to be involved in protecting and enhancing the stream and this should be supported and encouraged.

Recommendations for the site include:

- Working with Auckland Council and the local community to develop a restoration plan for the inanga spawning site, and for further downstream
- Working with Auckland Council and the local community to develop a pest management plan for the site and to implement pest trapping
- Continuing to work with Browns Bay Primary and Browns Bay Keas to monitor the site and implement an action, such as a litter clean up or planting day
- Continuing to support the local community at planting and weeding bees
- Continuing to monitor the stream for water quality and spawning activity

Overall Project Conclusion

The WBC team feel that the project has been a great success this year, and has built on work undertaken in the 2017/18 financial year. It has been fantastic to continue to provide support for existing community groups, and to see real, tangible outcomes for the project sites, such as planting and pest trapping.

It would be great to continue working at each site during the 2019/20 financial year, particularly to implement some of the recommendations at sites introduced into the project in 2018/19.

WBC have been working with Council Healthy Waters to identify further sites that could be targeted in the new financial year. The following two sites have been selected based on ease of access, potential for inanga to spawn and willingness of the community or landowner to participate in the project:

- Karepiro Bay Stream, Ara Weiti Road
- Otanerua Stream, Hatfields Beach

The Whitebait Connection would like to take this opportunity to thank the Hibiscus and Bays Local Board for supporting this project and we hope to work with you again in the future.



Photo: One of three potential streams on the Ara Weiti Road development site

Appendix 1 - Survey Methodology

Saline Wedge Mapping

To locate areas with potential for inanga spawning you must first locate the saline (tidal) wedge on the stream. The saline wedge is the point at which salt and freshwater meet on a high tide. As the tide pushes up a stream or river it meets the freshwater flow. The limit to which it pushes upstream will depend on freshwater flow rate at the time (which is influenced by rainfall) and tide height (which is influenced by the lunar cycle and onshore winds).

As saltwater is heavier than freshwater, it pushes underneath the downstream freshwater flow, thereby creating a saline 'wedge' (where water is saltier at the bottom than at the top of the channel). The location of this wedge varies over time due to the environmental factors listed above. In some systems, a natural or manmade barrier stops this process and the upstream movement of saltwater is prevented.

The saltwater wedge was mapped at both study sites. Saline wedge monitoring was undertaken using the guidelines the Whitebait Connection Guidelines - **Inanga/Whitebait Find the Saltwater Wedge (Whitebait Connection and EOS Ecology)**.

Saline wedge monitoring at each site started one hour before a spring high tide. A salinity meter (Auckland Council equipment) was placed in the deepest part of the channel, downstream of where the saline wedge was thought to be located. Measurements were then taken from the bottom, mid and top of the channel at several locations working upstream until freshwater was found (less than 0.5 ppt). Measurements were then taken around this point until high tide had peaked to ensure the exact location of the wedge was mapped.

Habitat Assessment

Once the saline wedge has been located at a site, the habitat around this point can then be assessed for its suitability for inanga spawning. Factors influencing whether inanga will successfully spawn at a site include vegetation type, density and % cover, bank gradient, stock access, upstream and downstream barriers and bank maintenance.

Habitat assessments were undertaken at both project sites using the WBC guidelines - **Inanga/Whitebait Assessing Spawning Habitat Guidelines (Whitebait Connection and EOS Ecology).**

Water Quality Testing

Basic water quality testing was also undertaken at both project sites, by local volunteers and school students. Tests were undertaken using a Wai Care testing kit, which includes water clarity (using a clarity tube), water and air temperature (using a digital thermometer), dissolved oxygen (using a Chemets Kit), pH (using Fisherbrand test strips), Nitrates/nitrites (using Aquachek test strips) and Phosphates (using Microtest kit).

Results from this testing gives an indication of water quality at each site and highlight any source/s of contamination that may be entering each system.



Photo: Students from Orewa North Primary test a water sample from the Nukumea Stream (Sophie Twedde, WBC)

Fish Trapping

A fish survey was undertaken at each project site during the saltwater wedge survey and habitat assessment. Three Gee Minnow traps were placed in the stream upstream and downstream of the wedge, to try and find inanga that might be migrating up or downstream.

Traps were also set before each school field trip, so that the students could meet what is living in their stream. Results from these surveys indicate what fish species are present at each site at certain times of year but do not exclude the possibility of other species being present.

Installing Artificial Spawning Habitat

Artificial spawning habitat (straw bales) were used at both sites to create 'ideal' places for inanga to spawn. Artificial habitat is used at sites where natural habitat may not be present, to identify if inanga would spawn if suitable habitat were available. It is also useful at larger sites, where it is impractical to undertake an egg search of all available habitat.

Straw bales were installed in line with the **Inanga/whitebait Installing Temporary Spawning Habitat Guidelines (Whitebait Connection/EOS Ecology)**. Bales were installed in late February/early March 2018 and checked once a month for eggs until the end of June 2018. Three sets of bales were installed on the Nukumea Stream and two sets on the Rothesay Bay Stream

Inanga Spawning Survey

Spawning surveys were conducted on the Nukumea Stream on two occasions during the spawning season – new moon high tide in May 2018 and new moon high tide in June 2018 – to look for spawning activity.

Spawning surveys were conducted using the WBC Guidelines - **Inanga/Whitebait Finding Natural Spawning Sites Guidelines (Whitebait Connection/EOS Ecology)**.

Inanga Egg Search

From March through to the end of June, artificial spawning habitat located at both sites was checked for inanga eggs. Suitable habitat close to the bales was also checked.

Egg searches were conducted using the WBC Guidelines - **Inanga/Whitebait Counting Eggs/Assess Inanga Spawning Activity Guidelines (Whitebait Connection/EOS Ecology)**.

Pest Monitoring

Pest monitoring was undertaken with the help of students from Browns Bay School at the Rothesay Bay Stream, and Orewa North School on the Nukumea Stream. Pest tracking tunnels were used in conjunction with 'Good Nature' peanut butter chew cards. Tracking tunnels and

chew cards were placed at intervals along the stream banks, around the saline wedge, artificial spawning habitat and any suitable, natural habitat that could be used by inanga for spawning. Inanga eggs are particularly vulnerable to predation by rats and mice so it is important to know if these pest species are present at a site.

Chew cards and tracking tunnel cards were checked and replaced once a week over a 5 week period on Nukumea Stream and once a week for two weeks on the Rothesay Bay Stream. The results were recorded and analysed by the students. Results from pest monitoring can be used to guide pest control work.



Photo: Chew cards with evidence of rat activity (Sophie Tweddle, WBC)