Manaaki Whenua
Landcare Research

Landcare Research
DISCOVERY

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What's Inside:

The state of our towns and cities

In 1998 the Parliamentary Commissioner for the Environment published *The Cities and Their People – New Zealand's Urban Environments*. Now, five years on and following Jamie Lerner's (famed for his transformation of Curitiba in Brazil) visit to New Zealand it is timely to reflect on how integrated urban design and development is on the verge of becoming mainstream in New Zealand.

The worldwide escalation in the growth of towns and cities is reflected locally in New Zealand and our Pacific neighbours. But in a country as rich in land as ours, it has been easy to overlook the impact of our towns' activities.

The fact is pollution of our air, waterways and coasts and damage to natural ecosystems is escalating, especially in fast-growing areas like Queenstown Lakes (projected population growth to 2021 of 64%), Tauranga (46%), Selwyn (42%), the Western Bay of Plenty (36.7%), and Auckland (36%, taking the population from 1.3 million to 1.65 million).

Such growth is putting severe pressure on land, drinking water (quality and availability), and infrastructure such as roading, water and stormwater systems.

Faced with these prospects, adopting low-impact development approaches becomes imperative if we are to avoid a corresponding escalation in congestion, pollution, damage to wildlife habitats and biodiversity. As researchers working in collaboration with Māori and other stakeholders, we have an obligation to help hand the land, our towns and cities on to future generations in a viable state.

Robert Lamberts

Low-impact technologies have been advanced locally in the Christchurch City Council's *Waterways and Wetland Natural Asset Management Strategy* and in urban design manuals from other regional and district councils (Auckland City, Auckland Region and North Shore City).

Considerable research effort is now focusing on developing approaches that:

- reintroduce native biodiversity and harvest traditional "problems", such as stormwater, for reuse
- use natural systems and technological advances (for erosion/sediment control, energy efficiency)
- provide less disturbance to, and fragmentation of, ecosystems during development
- define cost-effective low-impact approaches
- maximise on-site management and minimise requirements for managing adverse effects off site.

This edition of *Discovery* contains articles that cover some traditional areas of environmental research and use of this as a platform for new approaches to urban design and development, striving to bring nature and ecological systems back to our cities for a more sustainable future.

Charles Eason
Science Manager,
Urban Environmental Management
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Photo credits: left to right, Harley Betts 1, 2, 6, 8, Dave Morgan 3, Landcare Research Slide Collection 4, 5, Peter Buchanan 7.

Research exposes barriers to building better cities

Most of us want cleaner and more environmentally healthy cities in principle. But putting principles into practice can be more difficult. Urban researchers from Landcare Research and the University of Auckland have identified key barriers to more sustainable development in some of our fastest growing towns and cities, and are now working to clear those barriers.

Many centres are undergoing intense urban growth. Auckland's population of 1.3 million is growing at a staggering rate of more than 18,000 people and 7500 houses each year. The resulting urban sprawl is putting severe pressure on land, on the quality and availability of drinking water, and on infrastructure such as roading, water and stormwater systems. The Auckland Region will spend $5 billion over the next 10 years replacing aging pipes and installing networks to service new housing development. And Auckland is not alone in servicing intense growth. Tauranga and Selwyn and Queenstown Lakes districts are among other areas experiencing similar pressures.

Dr Charles Eason, Landcare Research Science Manager, Urban Environmental Management, and Professor Jenny Dixon, head of the University of Auckland's Planning Department, are researching "Low Impact Urban Design and Development" (LIUDD) approaches, and the reasons why their uptake has been slow in New Zealand. Dr Eason says LIUDD concepts are cost-effective and can greatly benefit cities.

"LIUDD involves water- and energy-efficient architecture and engineering. It limits major earthworks on development sites to reduce soil damage. Damaged soil does not drain and filter rainwater as it should, and this leads to increased amounts of contaminated or sediment-laden stormwater runoff into our waterways. LIUDD methods include the use of roadside 'treatment walls', which are above- or below-ground filters that soak up road runoff, and 'raingardens', which are domestic gardens strategically placed and planted to soak up stormwater.

Birgit Rhode

Principles in practice: Landcare Research's new "green" building, currently under construction on Auckland University's Tamaki campus. This energy-efficient building was constructed according to LIUDD principles and has rainwater tanks to help conserve water.

"Habitats for native plants and birds are left intact. Vegetation and wetlands detain water, further reducing pressure on stormwater systems. Even simple strategies like reducing impervious surfaces around buildings can produce many benefits.

"Low impact practices in cities such as Singapore show that even in intensively populated areas we can bring nature back into the city. Stormwater is regarded as a resource not a waste product, and rain and stormwater tanks are being installed for people to reuse water."

But while LIUDD practices are becoming mainstream in some overseas centres, uptake has been slow here. Dr Eason and Professor Dixon interviewed developers, city and regional council staff, house buyers, and the wider community to find out why.

"There were a myriad of reasons," Professor Dixon says. "Each group had specific interests that influenced their willingness and ability to exploit LIUDD. Price concerns, planning and institutional barriers were among them. Some council policies were identified as restricting change, as were some conservative development practices. This was compounded by a lack of local technical and economic data to influence plans and codes. Also, while the wider community was dissatisfied with urban pollution, they were not really aware of LIUDD goals, or the need to conserve water resources.

"When viewed collectively, these conflicting factors are often perceived as competing or insurmountable impediments to change. Disagreement and litigation between some of our key stakeholder groups can also impede change.

Stephen Moore

The opposite of LIUDD: a large new subdivision development in Auckland. Major earthworks such as these cause extensive soil damage.

"LIUDD will not become mainstream until there are **collective** changes."

Landcare Research's Dr Eason says research has identified a four-pronged technique to progress LIUDD.

"We aim to demonstrate LIUDD's technical and ecological efficiency; to show its economic benefits; to strengthen and rationalise plans and regulations; and to get buy-in from all parties. We are now working on all four of these at once.

"I am optimistic that through doing this, LIUDD practices will start to become mainstream. The alternative is that cities such as Auckland will continue their sprawling growth, that water pollution will increase, and that urban New Zealanders will increasingly be alienated from the beauty and function of nature."

Funding: Landcare Research.

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New vision for expanding city

Landcare Research urban researchers are helping to create a map of the zones most suitable for new development in a fast-growing city.

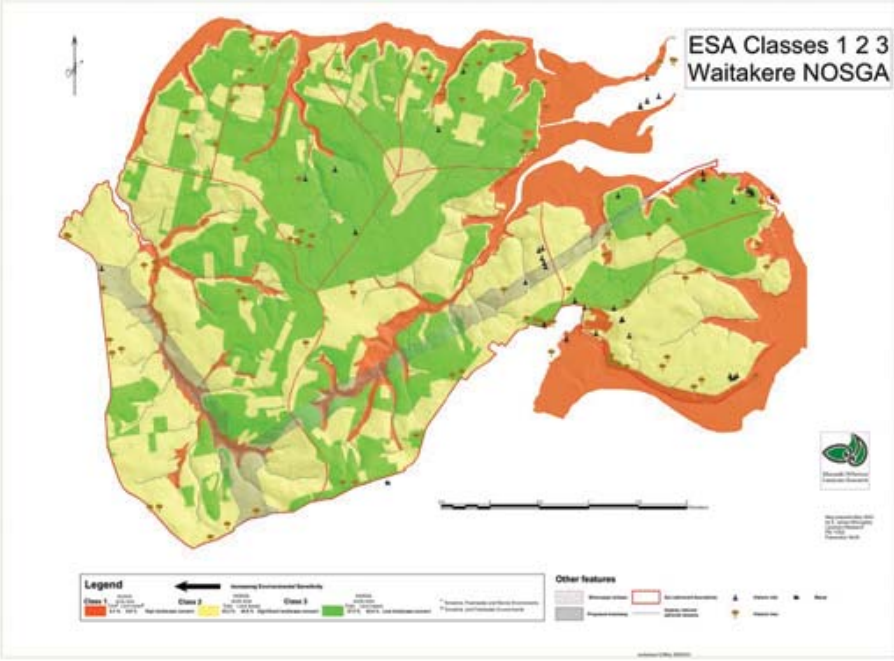
The Waitakere City Council is planning the development of the Hobsonville–Whenuapai area, the last predominantly rural land available for development in Waitakere City. The area comprises 2200 hectares and will be developed to accommodate 40,000 people within the next 50 years. The land drains into the ecologically sensitive estuaries of the upper Waitemata Harbour, which in the past have been affected by sediment and contaminants from poorly managed construction sites and road runoff.

The Council wants to safeguard the land and harbour, and make the area a model for sustainable urban development. Council staff were impressed by Environmental Sensitive Area (ESA) mapping, developed by Professor Hans Schreier of the University of British Columbia. They asked Landcare Research to create an ESA map.

Landcare Research scientist Sam Trowsdale says ESA maps combine biological, cultural and physical characteristics to identify sensitive areas at risk of degradation by land development. These can include streams and wetlands, for example, or heritage sites, or areas where natural hazards such as flooding or land instability directly constrain development.

"ESA Class 1 comprises areas of highest ecological value, such as native vegetation, and also areas where natural hazards make development difficult. It is recommended that areas of ESA Class 1 be excluded from development. ESA Class 2 mapped for the Whenuapai-Hobsonville area mainly includes areas of high aesthetic value and land used for horticulture that may have been contaminated through the use of poisonous sprays. This class also comprises areas of well-drained soils that could be used for stormwater management. ESA Class 3 comprises all other land. While some special conditions will be necessary when developing Class 2 land, development on Class 3 land will be subject to normal planning guidelines."

Through this approach, Dr Trowsdale says that areas suitable for different forms of land management are identified, and the impacts of their development on other areas can be foreseen. The process of prioritising the sensitivity of the land brought together the expertise of planners, and roading and



ESA classes 1, 2 and 3 mapped for Waitakere City's Hobsonville-Whenuapai area.

water engineers. This integrated approach to land use planning has produced a common vision for the Whenuapai-Hobsonville area.

Dr Trowsdale says the ESA approach does not threaten the process of urban development or lock up large quantities of land as "no-go" zones. "Only 7 percent is ruled out for development, and this is to avoid infrastructure problems in future."

The Waitakere City Council's Group Manager Asset Management, Tony Miguel, says the results of the work are pleasing. "We now have an inventory of basic land environments that we can use to decide the mix of land use and ecological protection for that northern area. The completed ESA is very visual and condenses what would have been numerous technical reports into an easily seen summary.

"We plan to use the system again to compile maps of our Twin Streams catchment, in the Henderson, Titirangi and Swanson areas. This will be more challenging, as Twin Streams has a mixture of rural and suburban environments."

Funding: FRST (Foundation for Research, Science and Technology), EcoWater Solutions, Waitakere City.

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Researchers get the real dirt on raingardens

Urban researchers at Landcare Research are finding out more about what raingardens can do for our cities, and which soils are best suited for them.

Simply put, raingardens are designed to take the place of your stormwater system and soak up and filter the water that comes off your roof and paved areas. In cities and towns, stormwater washes away contaminants such as vehicle tyre rubber, fuel combustion wastes and fertilisers that accumulate on hard surfaces during dry weather. Roads, roofs and footpaths in built-up areas stop stormwater from doing what it is supposed to do – filter into the ground. Instead, it is often discharged without treatment to local waterways and estuaries very quickly.

Building a raingarden is like building a pond on your section – except that it is filled with bark, soils, sand and gravel, and planted. It acts like a big sponge to hold stormwater, and lets it slowly filter into the ground instead of running off to stormwater drains.

Raingardens are increasingly being promoted by district and regional councils to retain and remove contaminants from stormwater, particularly in new suburban developments. But how do we make sure we have the most effective raingardens? Which soil is best at filtering contaminants?

Landcare Research scientist Dr Robyn Simcock and her colleagues are investigating designs for raingardens that can be retro-fitted into suburban New Zealand. As part of their search for the most effective raingardens, they constructed two experimental ones, planted in *Muehlenbeckia complexa*, a shrubby native species. One of the two raingardens contained a volcanic loam soil from Hamilton, and the other a clay soil common in the Auckland region. The clay soil was mixed with 20% sand to improve drainage.

Robyn Simcock

Raingardens can look like ordinary gardens, but they serve a special purpose. This domestic raingarden on volcanic soil uses low-growing native plants under an established pōhutukawa. It receives runoff directly from the carport roof.

Each raingarden was kept in a glasshouse and watered once a week for six months with artificial stormwater. This concoction contained nitrogen and phosphorus often found in fertilisers, and zinc, a heavy metal found in fuel combustion wastes.

Dr Simcock says the volcanic soil produced cleaner leachate. "Both soils stripped out the bulk of the zinc and the phosphorus, but leached a small quantity of nitrates. However, the volcanic soil easily outperformed the clay soil.

"The clay soil developed a subsoil that was inhospitable to plant roots, and was generating ammonium. Water ponded on top and the leachate was discoloured.

"When the soil dried out, the surface cracked, and when fresh stormwater was applied, it simply ran through the cracks. We extended the experiment from the planned four months to six months, to track its continued structural collapse."

Dr Simcock says homeowners or developers considering building a raingarden should ask their local council for information about the soil on or near their section, to see if it is suitable or if they need to bring new soil in.

"Soils have wide variations, even within suburbs. Even some clay soils have mineral structures that enable them to work extremely well in raingardens.

"Raingardens perform best when their soil has high carbon content, low fertility and high phosphate retention. These have the most pores for water to seep through and plants to grow, and a strong ability to retain contaminants."

Dr Simcock says future research will investigate how to improve the performance of clay soils, and focus on the role of plants in helping to strip contaminants. "We will also look at how long it takes raingardens to become saturated with contaminants."

Dr Simcock says it is already clear that raingardens do help clean up stormwater. "Also, they are easy to grow, and attractive to look at.

"If you are going to have a garden, why not have a raingarden?"

Funding: FRST (Foundation for Research, Science and Technology).

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"Stepping stones" can lead native birds back to cities

Work by Landcare Research shows how strategically placed patches of indigenous trees can coax native birds into our cities in larger numbers. However, while we have adequate numbers of native plants for this to happen, their selection and placement would need to be improved.

Many people want to see more native birds like tūī, bellbirds and kererū in our cities. A Christchurch City Council survey of 750 residents in early 2003 showed that neighbourhood support for additional native plants and birds varied between 58 and 70%. Throughout the country there have been many council and community-led native plantings in parks and along riverbanks and coastal areas.

Landcare Research scientist Dr Colin Meurk says his research shows that a minimum of 5% of a city should be in native trees for most native birds to survive there.

Colin Meurk

How an urban landscape with patches, "stepping stones" and corridors might look. This view over the outer Christchurch suburb of Halswell shows linked "clusters" of trees, as well as wetlands.

"Most cities have this already, thanks in part to replanting efforts, and also to pre-existing 'green belts' and forest remnants. However, for many native forest birds to make their home in our cities, we must make strategic connections or 'stepping stones' between areas of native plants.

"For most flighted birds, including our more common forest birds such as tūī, we ideally need 5–10 hectare sanctuaries of native large trees and other forest plants at distances no greater than 5 kilometres apart. Between these key sources, 1–2 hectare native forest patches should be spaced at about 2.5 kilometres and groves of 'noble' trees at 2–400 metre intervals. 'Noble' trees are our long-lived iconic podocarps such as tōtara and rimu, and also hīnau, kōwhai, tītoki, cabbage trees, and lemonwood. These trees provide huge larders for native birds.

"With this configuration, birds would always be within range of food, and there would be a ready supply everywhere of wind- or bird-dispersed seed."

Dr Meurk says maps of our major cities show that achieving these bird habitat patches would not be difficult.

"Even in older parts of cities, parks and reserves would fit these spatial criteria and it should be straightforward to incorporate them into new areas.

"However, these targets and ideals will not be achieved overnight. Even if planned plantings began today, it could still take more than a century for them to mature.

"The changes need not be dramatic for New Zealand cities to reclaim some of their unique biodiversity. The amenity values of European trees that many people love would continue to play a major role."

Dr Meurk says while strategically selected and placed native groves may bring some birds back to the city, survival of others may not be so easy.

"More sedentary species would need continuous linkages or corridors of native

plants. And unfortunately, some of our more rare species such as kiwi and kōkako may need thousands of hectares of continuous, predator-free forest.

"But for many more common birds, any small start will help – particularly in urban gardens, which can take up about 40% of urban land area. Native birds are likely to be attracted to home or public gardens that have native plants with nectar or fleshy fruit.

"Pūriri, pōhutukawa, tree fuchsia and rewarewa are particularly useful nectar sources in northern or wetter climes, and kōwhai and New Zealand flax, harakeke, in the south.

"Planting a single tree or bush in your garden may not lure back vast numbers of birds, but it does increase habitat availability for birds and helpful insects. It may also inspire your neighbours to think along similar lines. Remember that native plants are beautiful too! Many have dramatic sprays of white, yellow or red flowers.

"It would also be helpful if more nurseries supported the sale of a greater range of native plants, and promoted information about their place and function."

Diana Leufkens

Dr Colin Meurk measuring the growth of a young mānuka that has dispersed and regenerated spontaneously in a restoration experiment in urban Waitakere.

Dr Meurk says London and Berlin are inspiring illustrations of "green" cities overseas. "London has impressive parks and rooftop gardens, while Berlin has subsidised residents to have 'green roofs' and biodiverse gardens.

"Meanwhile, in New Zealand, many towns and cities are fostering native biodiversity. Waitakere City in Auckland prides itself on being an 'eco-city', Hamilton is replanting its gullies, and Christchurch has naturalised planting along its waterways. The Invercargill suburb of Otatara is preserving its coastal tōtara and saltmarsh vegetation and wildlife.

"All cities are making some efforts – and residents can play their part even in modest gardens."

Funding: FRST (Foundation for Research, Science and Technology), Christchurch City Council.

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City life can be fine for fish

Ever-increasing suburban sprawl may not appear to bode well for native fish in small streams near city perimeters. However, in some cases, development offers the chance to atone for environmental sins of the past.

The greater Auckland urban area from Orewa in the north to Papakura in the south contains hundreds of streams, many narrow, shallow and overgrown with weeds. But despite their often unattractive appearance, these streams can support a great deal of life, including native fish belonging to the eel, whitebait and bully families. The presence of these fish and stream invertebrates is being used as an indicator of the health of stream environments within new suburbs.

Landcare Research urban researcher Stephen Moore works with developers and environmental consultants to protect streams. Mr Moore assesses land development strategies and how these might negatively or positively affect stream health. He collates data for developers seeking resource consents to modify streams, and provides information to councils that influences urban design approaches. Mr Moore says while urban development can harm stream ecosystems, it also presents opportunities to heal damage caused by past land use.

Colin Meurk

An example of river bank rehabilitation at Christchurch's Heathcote River. The eroded bank was recontoured and replanted with rushes, sedges, New Zealand flax, cabbage trees, and other suitable native plants.

"Stream health is harmed by the removal of streambank vegetation and topsoil during development, and the hydrological cycle is affected when soil is compacted and impervious surfaces proliferate. Numerous

streams have had dams and culverts installed, and these can block fish from migrating from the sea. Others have been straightened or concreted. Still others have been used as rubbish dumps, or are over-run by weeds.

"Landcare Research is working with developers to manage land under development in new ways, to avoid detrimental effects on aquatic life and to enhance urban amenities. We help them adjust their development plans if necessary and encourage their use of low impact urban design and development approaches. By seeking to restore damaged land surrounding streams, they may well improve their chances of getting resource consents.

" I urge people to consider function as well as aesthetics when planting on properties with streams, and to use plants that are native to the area. Plants can provide stream bank stability and shade cover for stream life, including invertebrate food sources for fish. Landcare Research staff have expertise in advising on the best plants to select."

Mr Moore says he can assist a developer to make wise changes when they modify the course of a stream. "My advice to developers is that any modifications should look natural. In their original state, streams tend to have meanders, abundant plant cover and woody debris. They have a mixture of pools and faster flowing reaches, and backwaters

Rhonda Moore

Stephen Moore taking samples from a small farmland stream. This small, shallow stream may not look like much, but it supports eels and freshwater crayfish. A culvert below the stream has blocked many other native fish from using the stream.

where fish can take refuge from floodwaters. If the course of a stream presents problems for developers, we may be able to help restore a section of the stream after the development works."

Mr Moore says a side benefit of his work is that it has been helping to expunge some "urban myths".

"These include: 'urban development could only degrade that stream further', and 'that stream dries up in summer, so it won't support any fish'.

"I also try to increase people's general awareness of native fish. Often people do not realise there are fish in these streams at all. Our native fish hide during the day, and are not bright and colourful. However, they are an important part of our native ecosystems, and communities are increasingly valuing nature in the city.

"The bottom line is my work offers win-win outcomes for everybody: developers, the community and the fish."

Mr Moore's work focuses on Auckland and the Waikato, but has national relevance. . He has also compiled a comprehensive image database on CD of invertebrates found in stream environments nationwide. This CD is helping researchers to identify the types of invertebrates in their streams, and use these as indicators of stream health. The images on the CD were prepared with AutoMontage software that enables complete focus of microscopic objects.

Funding: Urban developers and councils.

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Researchers fish for answers on urban stream pollution

Researchers investigating the effects of pollution in urban streams and rivers are looking for answers in the fish and eels that live in them.

Major sources of pollution such as sewage outfalls are being increasingly regulated, and are therefore becoming less of a problem. However, other sources of contaminants such as fuel combustion waste and garden herbicides can be washed away by rain and find their way into urban waterways. But because the presence and concentrations of these contaminants vary greatly over time, it is difficult to measure their effects.

Landcare Research scientist Dr Louis Tremblay and Forest Research scientist Dr Mike van den Heuvel discussed these issues with regional councils, community members, iwi, the Department of Conservation and industry. They believed that new stream monitoring methods were needed to better assess the effects of pollution on fish populations, many of which are in decline. Many Māori were particularly concerned about the effects of pollution on native eels (tuna), which are regarded as taonga.

In the first study of its kind in New Zealand, Dr Tremblay and his team examined eels and native common bullies, which live in nearly all New Zealand streams. "We looked for

raised levels of a liver enzyme that responds to pollutants found in pulp and paper mill effluent, fuel combustion wastes and some pesticides. Overseas studies show that prolonged periods of raised enzyme levels are linked to cancer.

"Traditional monitoring focuses on measuring chemicals in the water, but this does not tell us if the chemicals are affecting the fish. Our approach can show a direct cause and effect link between the presence of certain chemicals and poor health in fish.

"This is important, especially when you consider that the impacts on fish indicate a potential health effect on humans, and of course, a reduction in the quality of urban streams."

Dr Tremblay and his team set up five study sites at suspected "problem" areas. These were: the Tarawera River near Kawerau's pulp and paper mill, the Waikato River at urban sites in Hamilton and Cambridge, the Waiwhetu Stream in Lower Hutt, the Styx River in urban Christchurch, and the Cam River, which runs past a sewage outlet near Rangiora.

The researchers caught fish at these sites, and kept eels caged there. They then tested for a variety of physiological changes.

Katherine Trought

Louis Tremblay making sure that eels kept in Christchurch's Styx River are in good condition and can swim around freely. The eels were kept in the river for three weeks, and were checked daily.

"Our results are still being analysed, but they do show raised liver enzyme levels in both eels and bullies in all of these rivers, particularly the Tarawera and Styx.

"The only exception was Lower Hutt's Waiwhetu Stream, because we could not find any common bullies in it at all, probably due to the level of degradation."

Dr Tremblay says the results will help show whether pollution in these urban catchments is in fact reducing fish populations. "The data will be of great relevance for protecting the New Zealand environment, as we are using native species. This in turn will help identify areas that need to be improved, and provide insights on the management strategies required to remediate negative effects."

The project is now in its last year. The findings will be presented at a series of hui near the study sites, and will also be displayed on the Landcare Research website.

Funding: Ministry for the Environment Sustainable Management Fund, Environment Bay of Plenty, Carter Holt Harvey Tissue, Norske-Skog, Environment Waikato, Carter Holt Harvey Pulp and Paper, Waimakariri District Council, Environment Canterbury, Christchurch City Council, Wellington Regional Council.

Mike van den Heuvel, Forest Research

The Waiwhetu Stream, Lower Hutt. This stream is one of the most degraded of the waterways studied, and was the only one where no common bullies could be found.

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