Impact of urban activities on freshwater and coastal environments

Mark Heath, Evan Harrison, Claire Conwell, Megan Oliver,

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Agenda

Part 1. Impact on freshwater environments

Part 2. Impact on coastal environments

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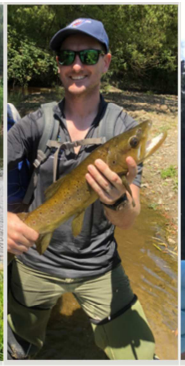
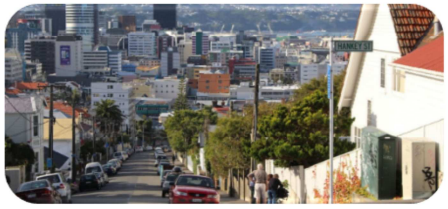
Scientists

Megan Oliver	Evan Harrison	Mark Heath	Claire Conwell
			
Coastal scientist	Freshwater Scientist	Freshwater scientist	Coastal scientist

Combine with above… introduce everyone

Impact of urban activities on the freshwater environment



Evan Harrison & Mark Heath

Environmental Science

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Urban freshwaters

- Rivers
- Streams
- Piped streams
- Aquifers
- Seeps
- Wetlands
- Drains

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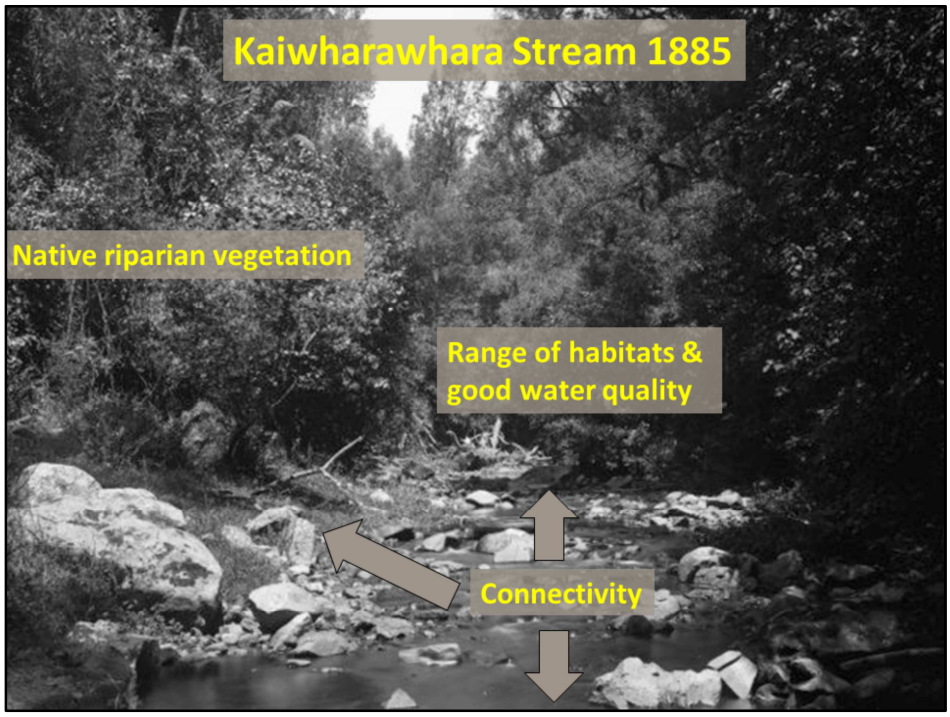
Lots of different freshwater environments.

This talk will focus on the first 3 of these in urban environments.



Historic perspective. Kaiwharawhara Stream. 1885.

Historically streams in Te Whanganui a tara were characterised by:
- Connectivity to the coast
- Riparian vegetation – which provided shading, organic matter
- Range of substrate sizes
- Range of habitats
- Good water quality
- Hydraulic heterogeneity

This is before urban intensification

Date: [ca 1885]
Ref: 1/1-025713-G
Kaiwharawhara Stream and surrounding bush, Kaiwharawhara, Wellington, circa 1885, photographed by William Williams (1859-1948).
Note on back of file print reads "[identified from captioned print in album PA1-o-592,

page 9]"
Quantity: 1 b&w original negative(s).
Physical Description: Glass negative
Access restrictions: Partly restricted - Please use surrogate in place of original
Format: 1 b&w original negative(s), Negatives, Glass negative
See original record

http://www.epic.org.nz/records/22712743?search%5Bi%5D%5Bcentury%5D=1800&search%5Bi%5D%5Bsubject%5D%5B%5D=Wellington+Region&search%5Bi%5D%5Bsubject%5D%5B%5D=Rivers&search%5Bpage%5D=3&search%5Bpath%5D=photos

Key point is that these are the streams/waterways that people interact with on daily basis …. Whether it be dogs…bikes…

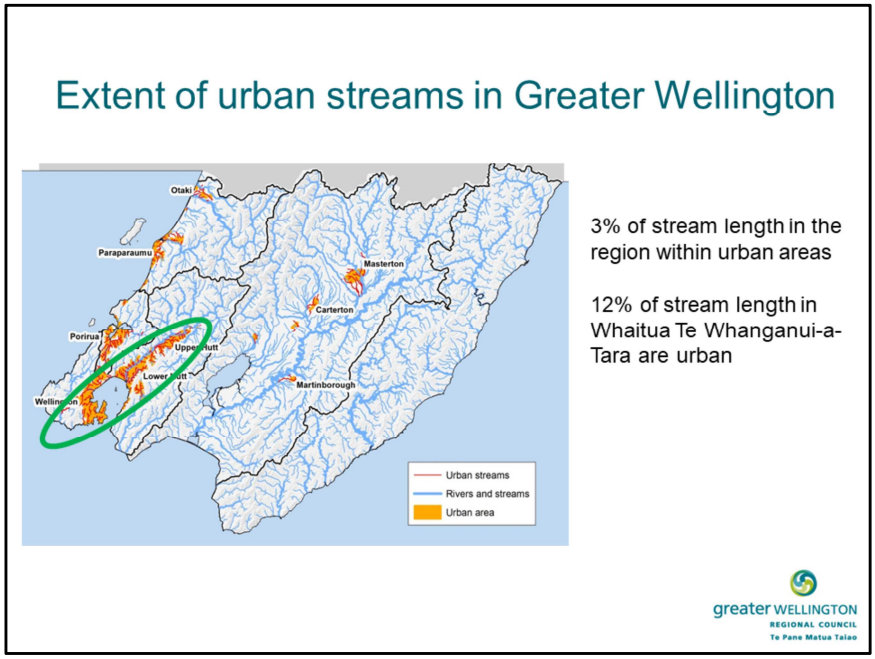
LINK to coast…

Although not the most abundant stream type, urban streams are probably the streams that people see most often, over 85% of wider Wellingtons population are urban dwellers.

You might walk past an urban stream on your way to work or walk your dog along it in the evenings.

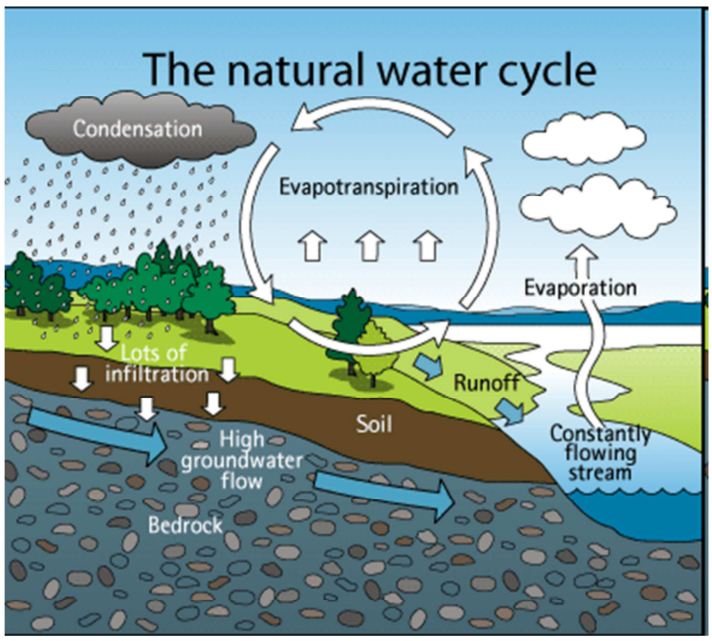
They are an important part of the urban landscape

Urban streams are also important in that they can flow into larger rivers, estuaries and harbour which are popular areas for swimming and other types of contact rec.



Urban streams represent about 3% of the total stream length in the greater Wellington region.

In Te Whanganui-a-Tara Whaitua, 196 km of streams are classed as urban. This corresponds to about 12% of the total stream length in this area.



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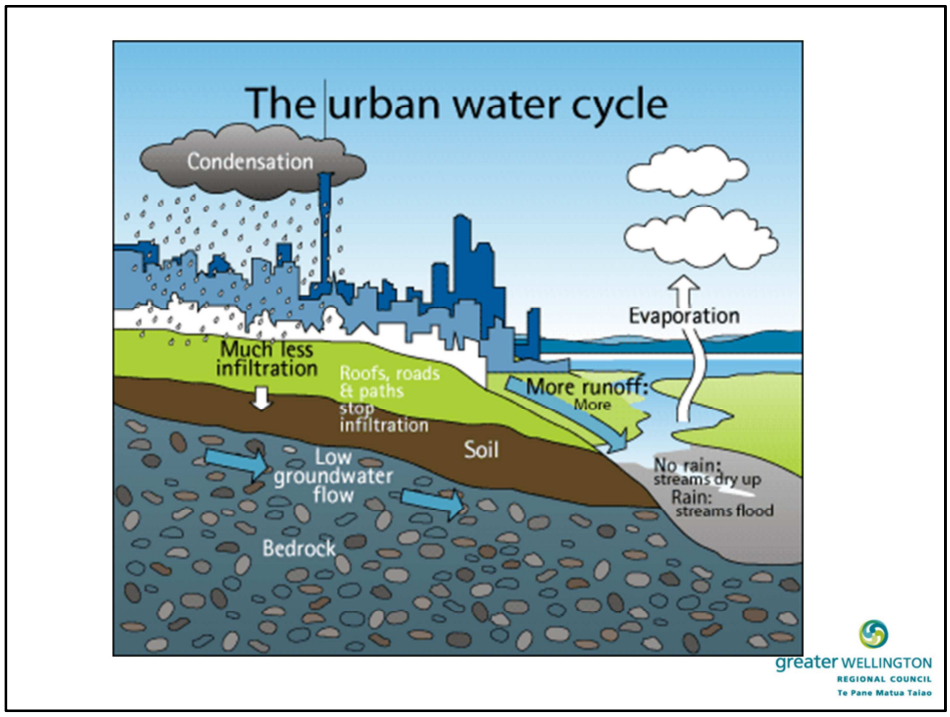
Functioning stream ecosystem

Kaiwharawhara S.

http://www.aucklandcity.govt.nz/council/documents/technicalpublications/TP232%20Framework%20for%20monitoring%20and%20assessment%20of%20urban%20streams%20in%20the%20Auckland%20Region.pdf

Stream functions:

- Connectivity to the coast – why is this important…
- Riparian vegetation – provides shading, organic matter input
- Range of substrate sizes
- Range of habitats
- Good water quality …. Ie. Low metals, nutrients… contaminants in general
- Hydraulic heterogeneity (areas of different current strength)



Important to make link to the fact that this water ultimately finds its way to receiving environments carrying anything it picks up along the way.

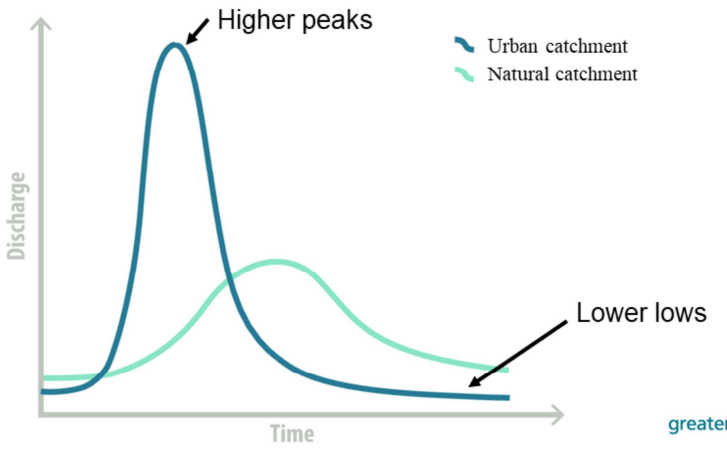
Disruption to natural cycle
Impervious surfaces are hard surfaces, such as sidewalks, streets, and rooftops, that don't allow water to seep into the ground. Water that does not soak into the ground becomes runoff and travels to the nearest body of water.

Impervious Surfaces Increase Runoff
Impervious surfaces are hard surfaces, such as sidewalks, streets, and rooftops, that don't allow water to seep into the ground. Water that does not soak into the ground becomes runoff and travels to the nearest body of water.

As the amount of impervious surfaces increases, more runoff is created and less water is able to sink in, or "infiltrate," into the ground. Infiltration is very important because water that travels slowly to creeks and streams sustains their flows through drier spells, which is good for aquatic life. Water that travels slowly through the ground also gets filtered by natural processes before it reaches the water body.

Water that travels too quickly to creeks and streams can pick up and carry a lot more sediment and other pollutants. It also hits creeks and streams in a rush, which worsens erosion and flooding.

Change in natural flow regime



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Disruption to the natural cycle moderately disturbed

Owhiro S.

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Moderately disturbed. Some armouring is indicative of faster runoff, which creates bank erosion & sediment inputs to the stream. Much less riparian canopy.

Disruption to the natural cycle badly disturbed

Kumutoto S.

Kaiwharawhara S.

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Urban streams channels are often highly modified, having been straightened, concreted and have little riparian vegetation. This results in urban streams being poor habitat for stream life such as invertebrates and fish.

Urban stream channels are usually modified to move stormwater as fast as possible through the system and minimise flooding – so habitat degradation of urban streams is closely linked to the increase in stormwater inputs in urban environments that we discussed earlier.

Another type of habitat degradation that's common in urban stream catchments is barriers to fish passage.
This perched culvert is an example of a barrier to fish passage which reduce the number and species diversity of fish in urban streams.

Over 95% of streams in wellington city are piped

https://stephengibbsdms.wordpress.com/tag/hidden-streams-of-wellington/

When the earthquakes in 1848 and 1855 (the latter was 8.2 on the Richter scale) reformed the city – Oriental Bay was uplifted by 1.5metres – reclamation and draining the wetlands and swaps were a priority for the authorities. Most of the waterways were severely polluted, so the solution was piping and culverting the streams underground.
Nowadays, in 2016, the Hidden Streams of Wellington amount to 95.5% of the waterways in the city – **only 4.5% of the streams are unpiped**.
Statistics can obscure the facts, so another fact is important.
Only 25 kilometres of unpiped streams exist in Wellington – **550 kilometres are piped underground**!!!!!

Stormwater from urban areas also contains a range of contaminants including toxicants, nutrients and bacteria

Roads and vehicles are a key source of contaminants, these include:

- Zinc from the wear of car tyres
- Copper from wear of vehicle brake pad linings
- Polycylic aromatic hydrocarbons (or PAHs) from vehicle exhausts and oil

Also herbicides used to spray roadside verges.

We frequently measure high concentrations of heavy metals at our urban streams sites
In 2005 and 2006 we tested the sediments of a range of urban streams across the Wellington region and in some we measured significant concentrations of toxicants. Opahu Stream in Lower Hutt was one stream that had toxic concentrations of PAHs.

Industry is another area of high risk in urban areas
On poorly managed sites chemicals can be washed into stormwater drains through yard wash down and by chemicals being poured directly down the drain..
Construction sites can also be a key source of contaminants to urban streams – particularly sediment

But we mustn't forget that what we do in our own homes and backyards can end up contaminating urban streams, for example:

- Using fertiliser and herbicides used in gardens and lawns
- Washing paint and other chemicals down stormwater drains
- Washing cars on the street rather than on the lawn or at a carwash
- Not cleaning up after pets – eg dog droppings on the lawn or in the street end up in the stormwater – FST has picked up contamination from dog faeces at a number of urban stream and coastal sites

There has been more than 20 sediment and paint call-outs this year on the Kaiwharawhara Stream alone.

Wastewater over flows /cross connections

Wellington's urban streams are failing to meet clean water targets

KATIE CHAPMAN
Last updated 05:00, August 26 2015

Water quality in urban streams, such as Kaiwharawhara Stream, is declining, a report shows.

Landfill runoff

Forget clean and green - this Wellington stream is brown, bubbly and litter-strewn

TOM HUNT
Last updated 12:48, April 17 2017

Ovhiro Bay resident Jane Poata says the Ovhiro Stream's smell reminds me of the Mapua toxic site.

Wellington stream brown, swollen and frothy

TOM HUNT
Last updated 15:47, November 28 2016

The Ovhiro Stream has turned brown and foamy.

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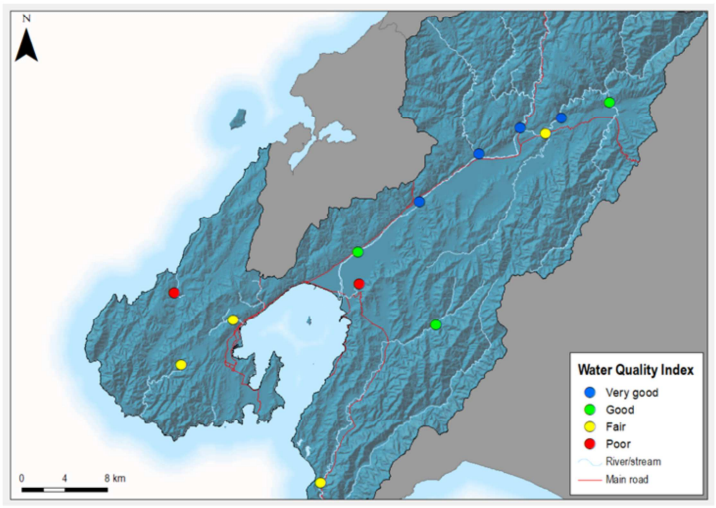
Water Quality Index



dissolved oxygen, visual clarity, nitrite-nitrate, ammoniacal nitrogen, dissolved reactive phosphorus, *E. coli*

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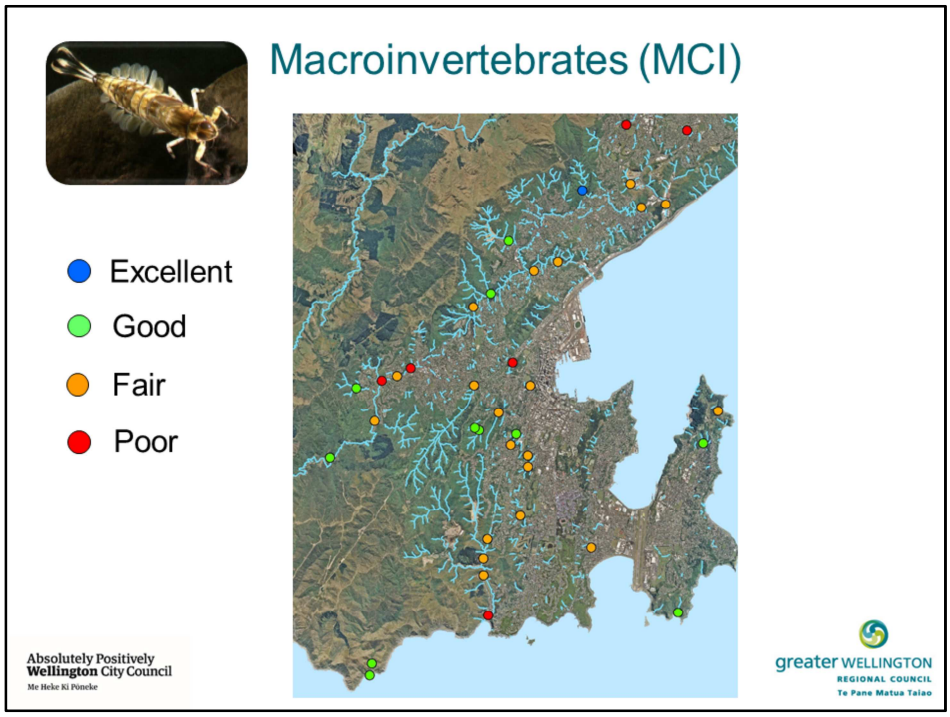
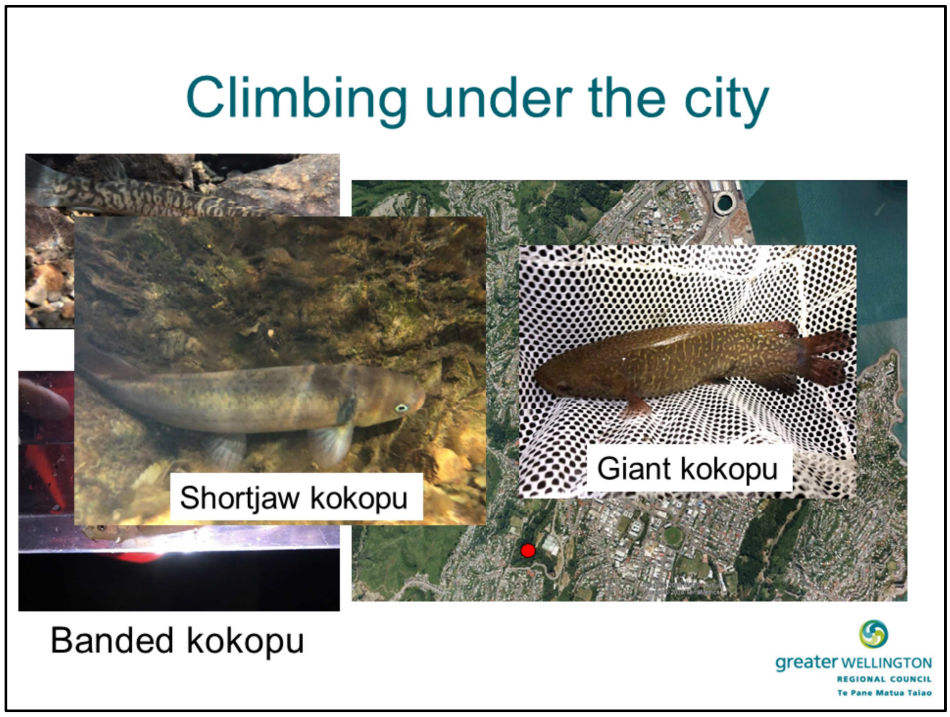
Water quality in urban streams is typically fair/poor



Stream health indicators like the Macroinvertebrate Community Index also show fair/poor health in urban streams.



Amazingly, fish are still found in some urban streams when they are piped – typically when there are open streams in the headwaters, esp in bush (such as the stream sources around Wellington's green belt). Only good climbing species though (koaro, banded kokopu); poor climbers like giant and shortjaw kokopu are not found in these piped streams.

Piped stream surveys

Alex James – EOS Ecology

https://www.tvnz.co.nz/one-news/new-zealand/whitebait-eels-found-in-wellingtons-stormwater-system

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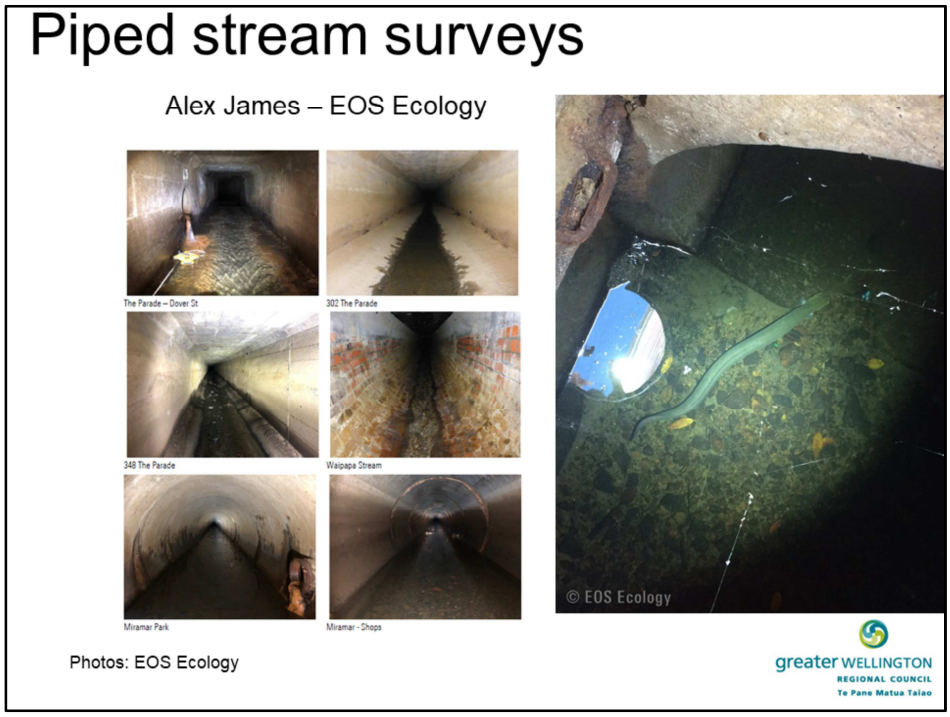
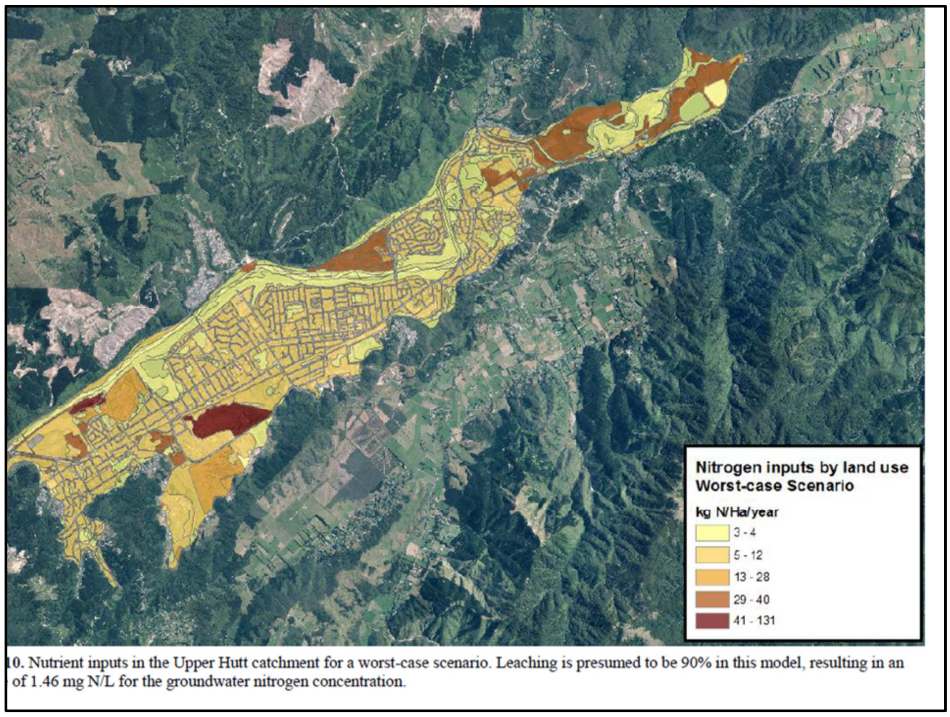
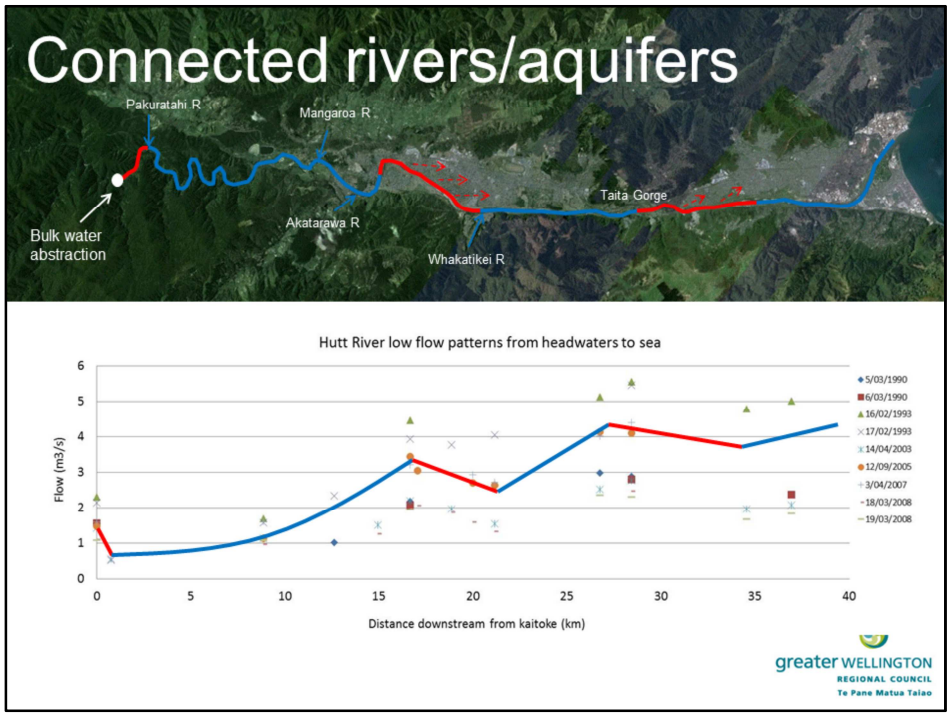


Another aspect is understanding the value of piped streams, esp the older brick pipes which have rough surfaces that slow water enough for fish to climb.



10. Nutrient inputs in the Upper Hutt catchment for a worst-case scenario. Leaching is presumed to be 90% in this model, resulting in an of 1.46 mg N/L for the groundwater nitrogen concentration.

Largest nitrogen inputs from urban areas are open space/parkland such as golf courses.


Connected rivers/aquifers
Pakuratahi R
Mangaroa R
Bulk water abstraction
Akatarawa R
Whakatikei R
Taita Gorge
Hutt River low flow patterns from headwaters to sea
Flow (m3/s)
Distance downstream from kaitoke (km)
5/03/1990
6/03/1990
16/02/1993
17/02/1993
14/04/2003
12/09/2005
3/04/2007
18/03/2008
19/03/2008
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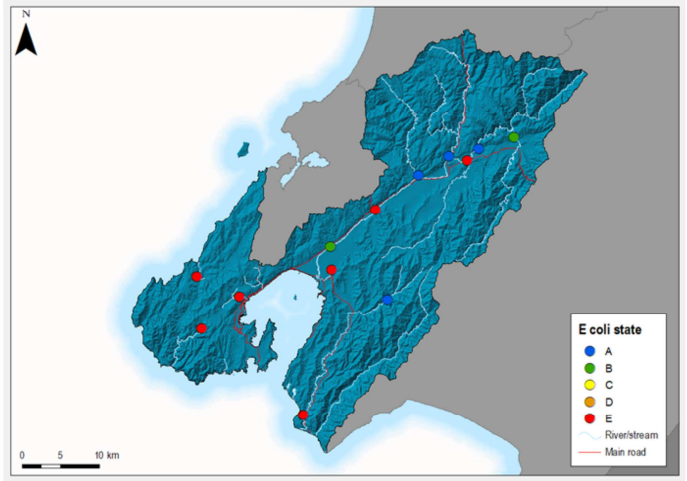
Pathogens widespread



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Restoring fish connectivity Polhill Stream

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Vegetation regeneration

Polhill Reserve,Wellington

1938

LINZ

2018

Google Earth

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Part 2. Impact of urban activities on the coastal environment

Megan Oliver & Claire Conwell
Environmental Science

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When we think of the coastal environment, it is important to remember that there are numerous different types of habitats, and the vulnerability of these habitats to various pressures or activities, differs greatly. Estuaries for example, are particularly vulnerable because they are low energy, depositional environments and are sinks for contaminants.

Key urban impacts for coastal environments

- Pollution (metals, nutrients, pathogens)
- Fine sediment inputs
- Habitat loss
- Ecosystem function loss
- Climate change

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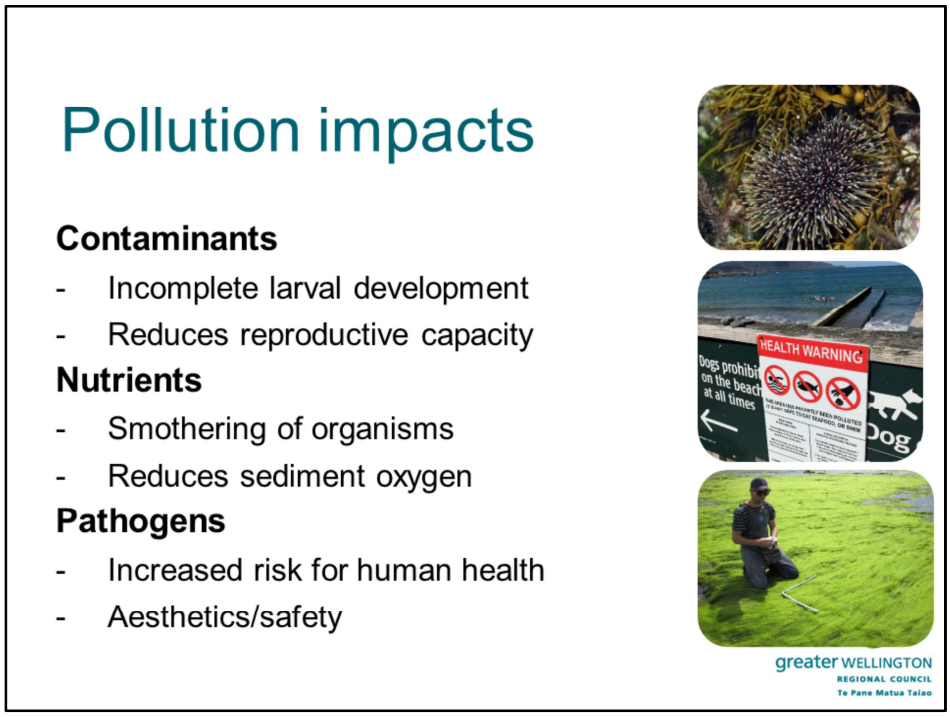
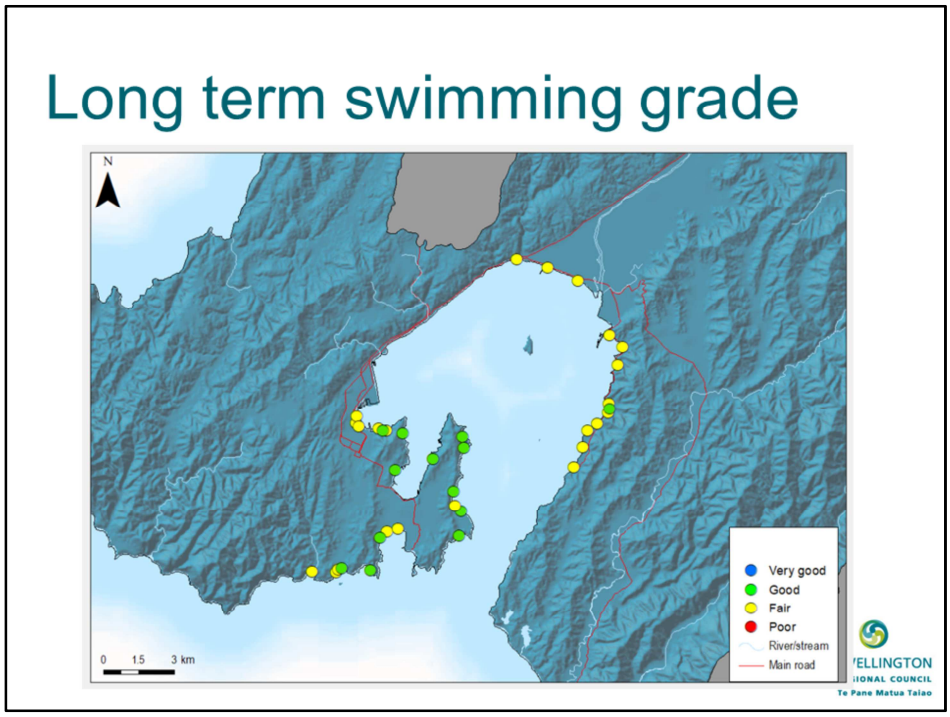
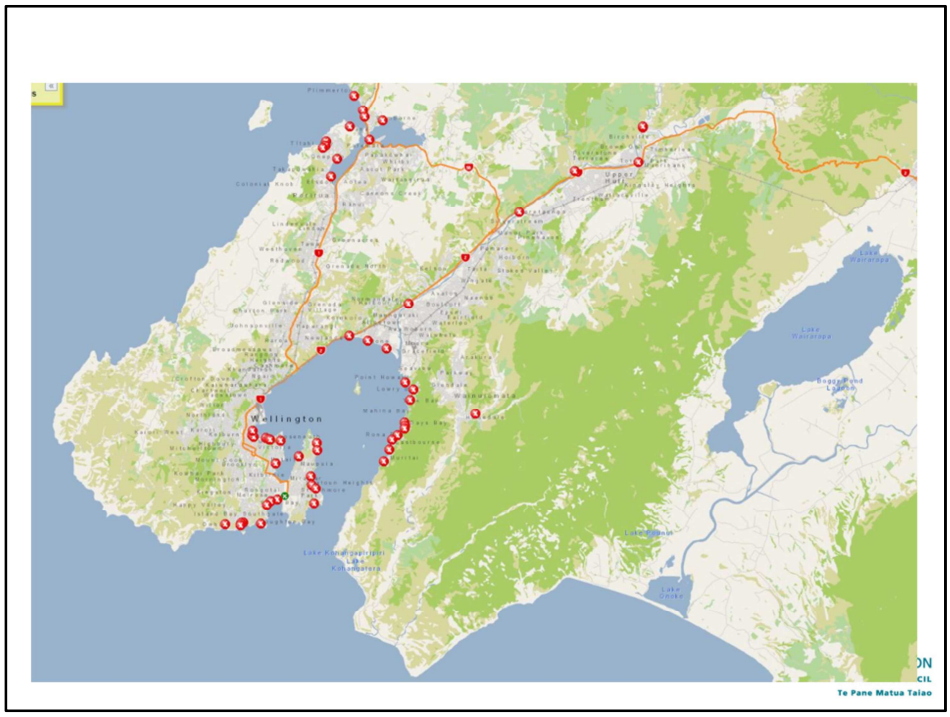
The key impacts on coastal habitats can be summarized into these five themes



Pollution includes stormwater contaminants, nutrients, and pathogens from wastewater. Metals such as zinc and copper are known to retard larval development of important kai moana species such as kina and paua. Metal contaminants entering via the stormwater system also reduce the reproductive success of a range of marine invertebrates and affect larval survival.
Nutrients, such as nitrogen, from wastewater and rural run-off, fuel algal blooms which smother other organisms and reduce sediment oxygen.
Pathogens from the wastewater system are a greater issue for human health than ecological health, and can make people sick via contact with water or contaminated food, and sites unsafe for recreation where rubbish and litter accumulate.
It is important to note that there are likely to be many emerging contaminants (personal care products, pharmaceuticals) that are impacting the environment but that we do not monitor for yet.



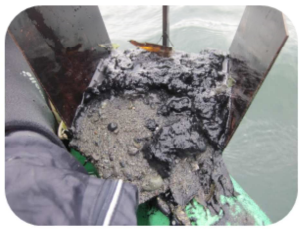
Here is one example of how pathogen pollution (i.e. bacteria) can influence the risk to human health.
This map of Wellington Harbour shows the long term swimming grades – these represent data compiled from 3 years' of surveillance monitoring (typically weekly grab samples) taken over the summer bathing season (1 December to 31 March each summer). Data are assessed according to the categories 'Very good' to 'Poor' in accordance with the 2003 Microbiological Water Quality Guidelines.
The important thing to note here is that these are long term grades – they do not indicate the risk to human health immediately following heavy rain – this is demonstrated on the next slide.



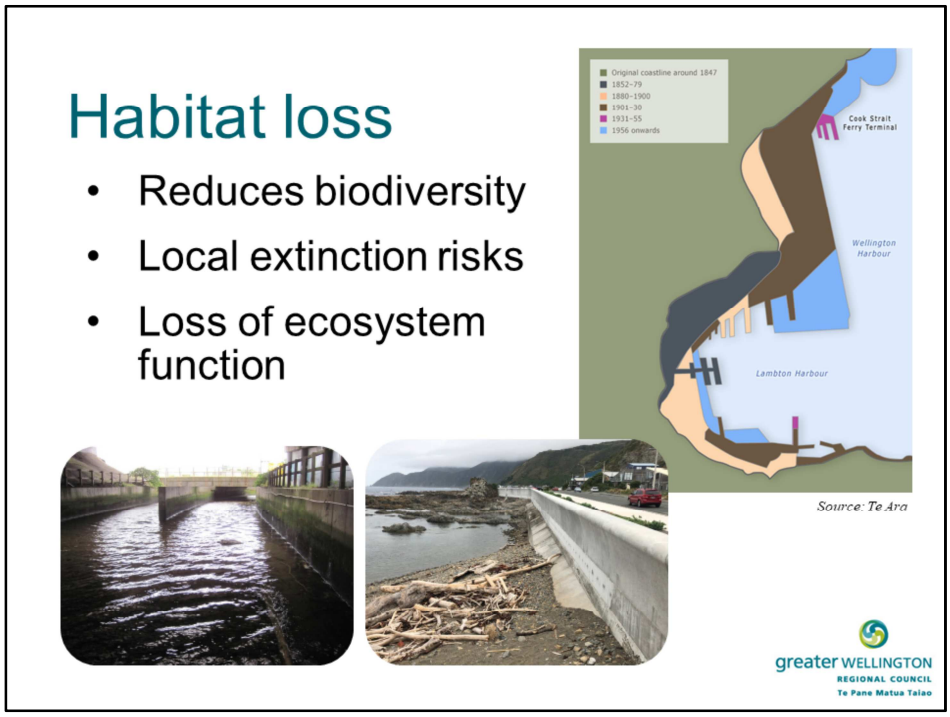
This map is displaying the risk of swimming immediately following a period of heavy rain across the region – this shows that immediately following heavy rain, recreational swimming is not advised and risks to adverse health outcomes have increased. Contrasted with the long term grades that show the suitability over a long time period, the immediate effect of heavy rain shows that swimming sites can be immediately impacted by runoff, meaning that these sites are not suitable for swimming at that time. This is consistent with the advice from Regional Public Health, and international advice, to not swim for at least 48 hours after heavy rain, as sites can become polluted with stormwater runoff and potentially wastewater overflows.

Fine sediment impacts

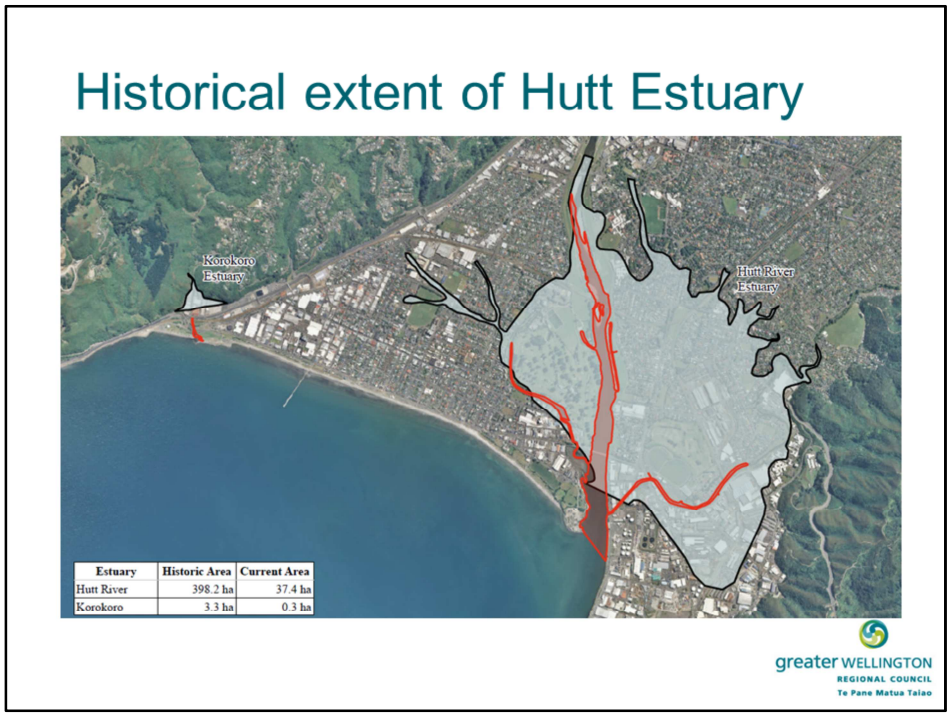
- Smothers plants and animals
- Reduces sediment oxygen
- Reduces clarity
- Increases muddiness



Excessive fine sediment inputs can smother and kill plants and animals, reduce the amount of oxygen in the sediment, reduce water clarity which is an issue for visual predators, and increase muddiness. Muddy, smelly, poorly oxygenated sediments do not support healthy animal and plant communities.



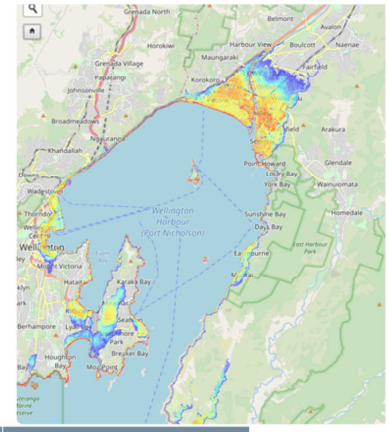
Habitat loss results in a direct reduction in biodiversity and the risk of local extinction. Seagrass in Wellington Harbour is an example of a habitat-forming (biogenic) species at risk of local extinction. Seagrass meadows are amongst the most productive habitats on earth and provide habitat and food for a range of species. In turn, as species and habitats are lost, so are the valuable ecosystem services and functions that they provide to us; nutrient cycling, wave attenuation, erosion protection, food, sediment trapping, carbon sequestration and so on.
As noted earlier, marine habitats vary greatly in their ability to withstand different pressures.



This map shows the historical extent of the Hutt Estuary (in pale blue) and the present day extent (in red). The channelization and constriction of what was once an extensive wetland/saltmarsh/estuary filtration system, severely restricts the ability of the Hutt estuary to function as well as it should.
The historical and present day extent of the Korokoro estuary is shown in the left of the map. This stream and estuary are much steeper so the historical estuarine extent is not as great. Nonetheless, this estuary area will have once provided valuable filtration and nutrient cycling functions, as well as a range of habitats and a rich diversity of habitats and life, that estuaries are so well known for.

Climate change impacts

- Coastal squeeze
- Biodiversity loss
- Invasive species



Variable	Mid Century	End-of-century
Ocean pH	-0.16	-0.33
Water temperature	+1	+2.5
Nitrate	No change	-0.5mmol/m3
Phosphate	No change	-0.04mmol/m3
Sea level	+0.5m	+1.0M

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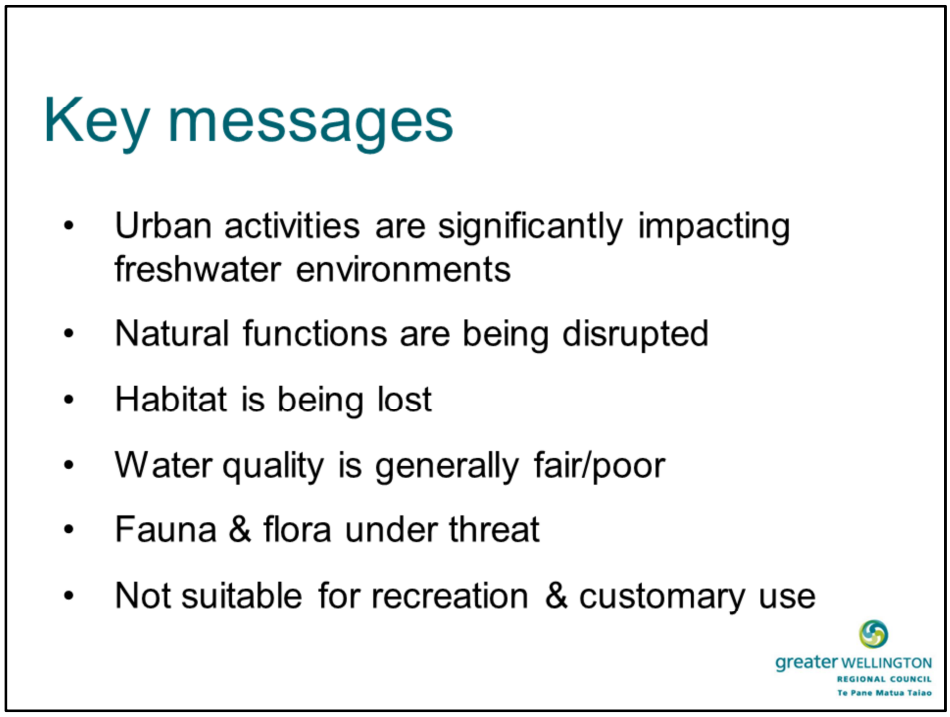
Climate change will exacerbate all of the impacts mentioned above. In addition to all of the pressures that a changing climate is having on marine habitats (eg, increasing ocean temperatures, increasingly acidic ocean waters, for example), urban development right to the edge of the coastal zone is severely limiting the area available for coastal habitats such as saltmarsh to expand under the predicted sea level rise scenarios. Thus we risk losing more marine habitats and biodiversity, as well as further loss of ecosystem functions.



Ecology - Urban streams provide living and breeding space for freshwater fish, invertebrates and plants. Stream functions are affected by catchment-scale (e.g., land use) and local-scale (e.g., physical habitat) factors. Connectivity - Stream functions are determined in large measure by their connectivity between reaches from the headwaters to the sea. For example, many native aquatic species (e.g., fish) require access to the sea to complete their life cycles. Stream functions are also directly affected by connectivity with the riparian zone, the floodplain, and groundwater. For example, insects are an important food source for fish and birds, and have both aquatic (larva) and terrestrial (adults) life stages. Water Quality – Good water quality is necessary to support ecosystem functions and human uses in streams and coastal areas. Streams provide for the physical, chemical, and biological processing of contaminant inputs, including those related to wastewater and stormwater. Flood Management - Streams and their surrounding floodplains are the drainage network for a catchment and are an important part of the flood management system. Many urban streams have been highly modified (piped and channelised) to convey flood flows and protect property from flood damage. Conveying flood flows in upper reaches can lead to more severe flooding downstream. Amenity / Cultural – Streams in urban areas have a number of values related to human use. These values are often interrelated and include: • Amenity - Streams flowing through reserves (or private land) may include walkways or picnic

areas and are valued for their visual appeal. • Recreation - Paths along streams are popular for walkers and joggers. Non-contact recreational uses include kayaking in the lower reaches of larger urban streams, although full contact recreation such as swimming and playing are generally discouraged in urban streams to protect public health. • Cultural/Community - Significant cultural and/or community values are attached to a number of urban streams. Waicare groups, local Iwi, or other community organisations may have special connections to particular streams, and often participate in protecting and improving their condition. • Economic – Streams provide a variety of indirect economic benefits related to tourism, commercial and business uses, and property values. In addition, streams provide for the treatment, processing, and attenuation of contaminants at no direct cost. Managing public health in urban areas is important due to the high population density and levels of contaminants, including pathogens, in urban streams. Direct contact with urban streams is generally not recommended. The collection of aquatic plants (e.g., watercress) and animals (e.g., koura, eels) for human consumption is not recommended due to the high potential for exposure to contaminants and pathogens.