Auckland
Regional Council
TE RAUHITANGA TAIAO

Summary of the Ecological Health of Auckland Streams based on State of the Environment Monitoring 2000-2004

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1) Introduction and Scope

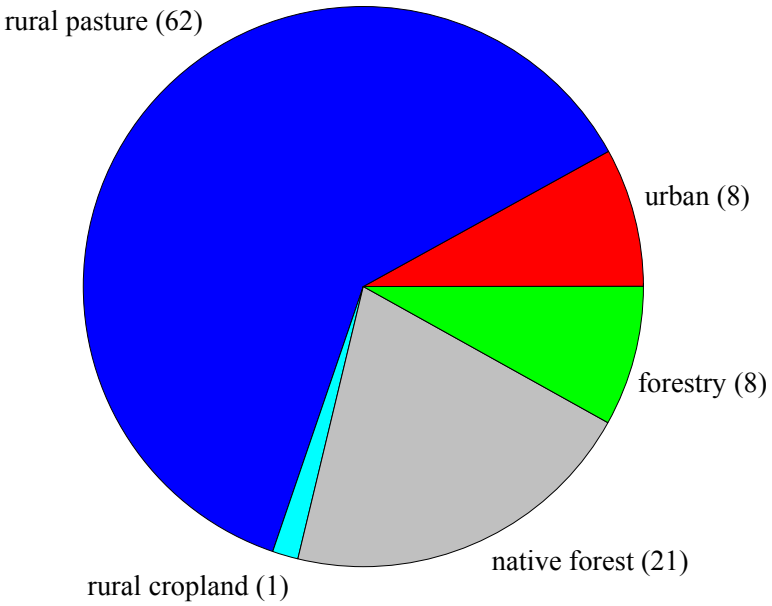
There are approximately 10,000 km of streams in the Auckland region (mainland) as mapped on 1:50,000 scale NZMS260 series topographic maps (ARC 2001). This is an underestimate of resource extent because many small streams are not mapped, and the mapping does not include ephemeral and intermittent streams that flow only during certain times of the year or during rainfall events. Research is underway to assess the extent, quality, functions of intermittent and ephemeral streams, and will be reported in future annual reports. In the narrow Auckland isthmus, catchments and their streams are small with 90% first and second order with a channel width of less than 2 metres. The data used to derive the following assessment summary were taken largely from these small wadeable mapped streams.

The vast majority of Auckland streams are in rural land uses, presenting 63% of the region by area (Figure 1). The remainder of the region is in native forest, urban, and commercial forestry land uses (Figure 1). These estimates were derived from 2002 satellite imagery (Ministry for the Environment, MfE, 2004). Further, the majority (approximately 95%) of Auckland streams affected by human activities are in "soft-rock" geology including clay and sand. The area of the region in "hard-rock" geology (e.g., cobbles and boulders) is limited to the Waitakere and Hunua ranges and mostly in protected native forest catchments.

The physical, chemical, and biological conditions of Auckland "soft-bottomed" (SB) streams is summarized below, utilizing data collected from a network of 41 sites representing the four major land use classes and two level of disturbance. Sites in each land use class (except the native forest reference class) were selected with "low" and "high" levels of human activity and disturbance. This site network provided the basis for delivering assessment results to a wide range of non-scientific decision makers including managers, planners, politicians, and the general public. These results are taken from a report documenting the development of a new biotic index for SB streams (Stark and Maxted 2004), and available for download from the ARC web site:

http://www.arc.govt.nz/arc/environment/water/publications/publications_home.cfm#ecology.

Figure 1. Proportion (percentages) of Auckland stream length for five land use classes, as derived from 2002 satellite imagery (MfE 2004).



2) Biological Quality

Biological quality of aquatic systems is assessed using living resources such as fish, invertebrate animals, and plants. We have used benthic macroinvertebrates, including the larval stages of insects, crayfish, snails, and worms, to report on stream health because these organisms are ubiquitous, easy to sample, and sensitive to disturbance. A macroinvertebrate community index (MCI) developed for hard-bottomed (HB) streams was modified for use in SB streams (Stark and Maxted 2004). Quality classes (e.g., good, fair, poor) derived for HB streams were found to be applicable to SB streams (Stark and Maxted 2004). Results are presented for four land use classes and two levels of disturbance within each class using the following criteria:

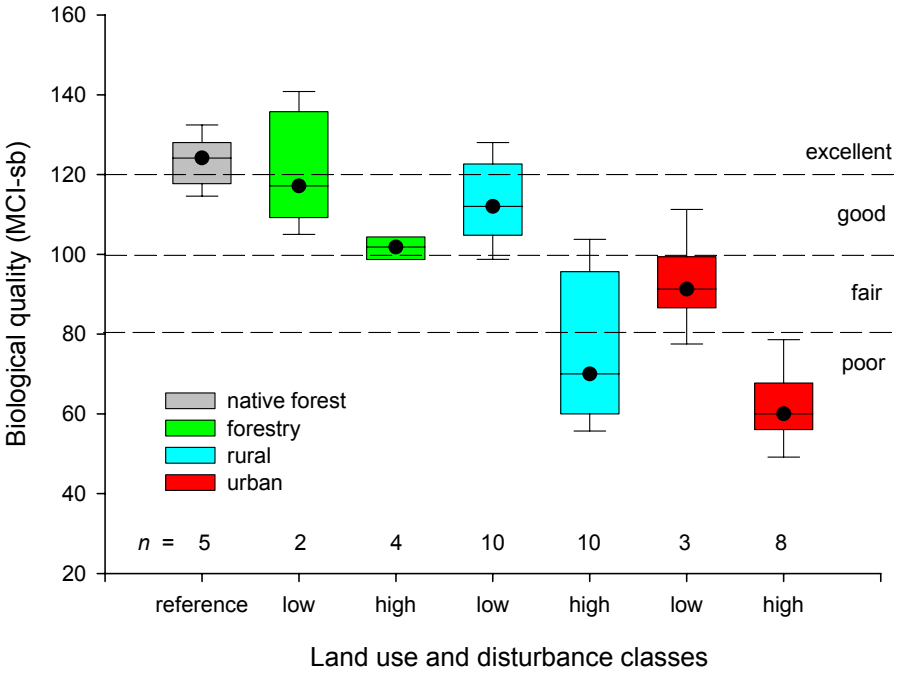
- Reference - greater than 95% catchment in indigenous or regenerating native forest, no roads, building, or dams; human activity limited to walking tracks.
- Forestry low - greater than 70% of the catchment in commercial forestry (pine), mature trees (> 25 years old) prior to harvest.
- Forestry high - greater 95% of the catchment in commercial forestry (pine) and harvested within the last 2 years.
- Rural low - greater than 15% of the catchment in rural land use, good habitat quality and stock exclusion in the reach assessed, low stock densities, and good riparian protection in the catchment.
- Rural high - greater than 35% of the catchment in rural land use, poor habitat quality and stock access in the reach assessed, high stock densities, and poor riparian protection in the catchment.
- Urban low - 10-25% of the catchment in urban land use.
- Urban high - greater than 40% of the catchment in urban land use.

Biological conditions generally followed a pattern of quality by catchment land use and the level of disturbance within each class (Figure 2). The majority of forestry and rural sites with low degrees of disturbance had "good" biological conditions, and some were comparable to reference sites. Rural and urban sites with high degrees of disturbance had "poor" biological conditions. Rural sites were highly variable. Urban sites with a low degree of disturbance had "fair" biological conditions indicating that impacts occurred in the early stages of urban development (10-25% urban land use). Forestry sites dropped in quality from "good" to "fair" after harvest.

Summary - Biological Quality

- reference > forestry > rural > urban
- low disturbance > high disturbance (forestry, rural, urban)
- "poor "conditions of urban sites due to poor water quality

Figure 2. Biological quality of Auckland soft-bottomed streams using the macroinvertebrate community index (MCI-sb) for four land use classes and two levels (low and high) of disturbance; *n* = number of sites; dots median values, boxes 25-75th percentiles, and whiskers 5, 95th percentiles.



3) Physical Habitat Quality

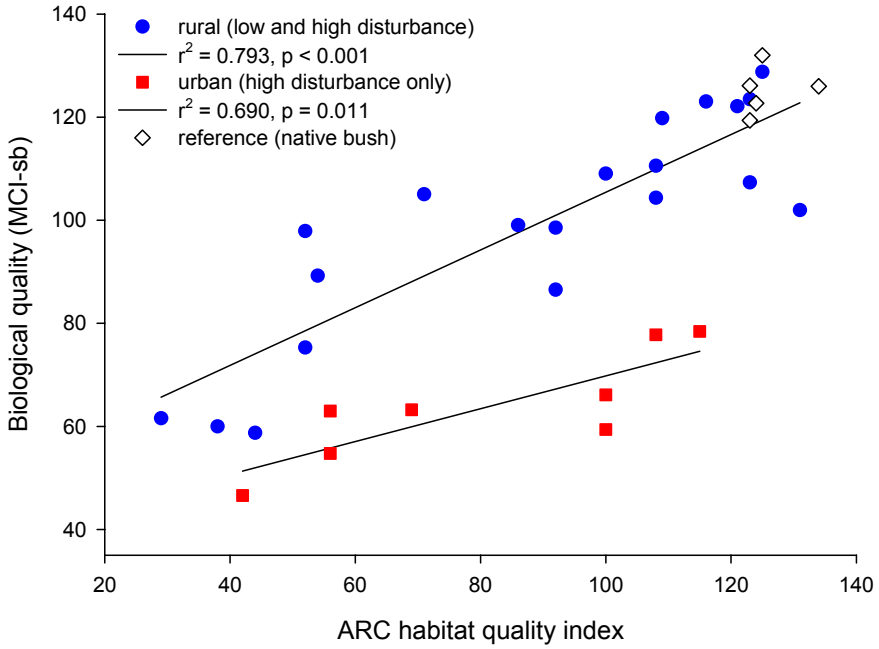
Physical habitat was determined for the 100 meter reach of stream where biological samples were collected. Sites were scores on a 140 points scale using seven measures of the stream channel, stream bank, and riparian vegetation. Sites with high scores (> 100 points) had natural channels with stable banks and native riparian vegetation shading the channel. Sites with low scores (< 80 points) were typically unshaded channels, often channelised, and in rural areas often had direct stock access.

Physical habitat was a major stressor affecting Auckland SB streams across all land use classes. Biological quality was strongly associated with habitat quality in rural and urban catchments (Figure 3). The 10 rural sites with a low degree of land use disturbance (habitat scores greater than 100 points) also had "good" biological scores (MCI-sb > 100). Rural sites with the lowest habitat scores also had the lowest MCI-sb scores. The effects of habitat quality on biological quality were evident even in fully urbanized catchments (Figure 3). All forestry sites, including those with mature trees, were adversely affected by sediment deposition that reduced the living space for fish and invertebrates.

Summary - Physical Habitat Quality

- major stressor affecting biological conditions across all land use classes
- urban sites with "good" habitat and "poor" biology adversely affected by "poor" water quality
- forestry sites with "good" biology adversely affected by sediment deposition

Figure 3. Associations between habitat quality and biological quality of rural (filled circles) and urban (filled squares) soft-bottomed streams in the Auckland region; reference sites (open diamonds) in native forest catchments also shown; mean values derived from 1-10 replicate samples collected from 2000-2004.



4) Water Quality

Stream water quality in the region is reported annually for 22 water quality parameters derived from monthly samples taken from 16 sites since the mid-1980's. Sampling sites represent the five major land uses classes and are distributed geographically across the region. The data are summarized in annual reports available for download from the ARC web site http://www.arc.govt.nz/arc/publications/technical-publications/ (ARC 2004). These data were used to rank SB sites using six parameters including dissolved oxygen, faecal coliforms, ammonia-nitrogen, nitrate-nitrogen, total phosphorus, and suspended solids (Stark and Maxted 2004).

Water quality, similar to biological quality, followed a pattern determined largely by catchment land use (Table 1). The best water quality was at the forestry site (75 points) and was comparable to the reference site (73 points) for the parameters assessed. The poorest water quality was found at urban sites; all urban sites had index scores less than 50 points. Rural water quality was highly variable, and likely dependent upon the intensity of rural land use in the catchment (Table 1). Water quality was strongly associated with biological quality (Figure 4). Other data and information indicate that the stream biota are also adversely affected by elevated stream temperatures (ARC 2004).

Summary - Water Quality

- native forest = forestry > rural > urban
- "excellent" water quality at the forestry site
- "poor" biology of urban sites due to "poor" water quality

Figure 4. Association between water quality and biological quality in Auckland soft-bottomed streams; relative rankings of 16 sites (see Table 1) using dissolved oxygen, nutrients, suspended solids and coliforms (Stark and Maxted 2004); reference (squares), rural (circles) and urban (diamonds) land uses.

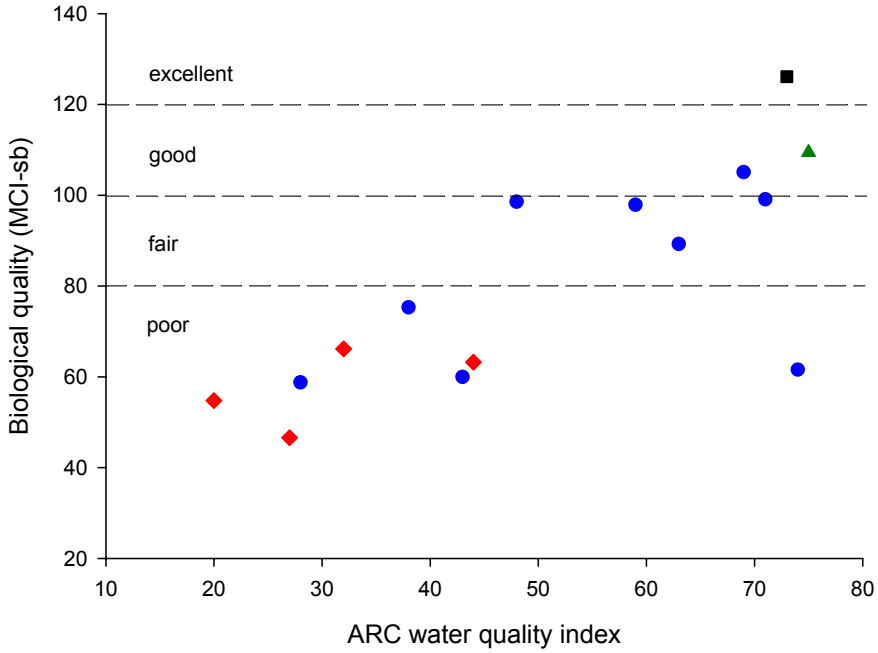


Table 1 – Water quality ranking from "best" to "worst" for 16 soft-bottomed streams in four land use classes; ranking scores derived using dissolved oxygen, nutrients, suspended solids and faecal coliforms data collected monthly from 1992-2003.

Site name	Land use	Ranking	
Mahurangi	forestry	75	best
Ngakaroa	rural	74	
West Hoe	native forest	73	
Wairoa	rural	71	
Matakana	rural	69	
Waiwera	rural	63	
Hoteo	rural	59	
Awanohi	rural	48	
Oakley	urban	44	
Vaughan	rural	43	
Kumeu	rural	38	
Oteha	urban	32	
Lucas	urban	30	
Papakura	rural/urban	28	
Puhunui	urban	27	
Otara	urban	20	worst

5) Management Implications

These results lead to the following recommendations for the management of streams in the Auckland region:

- Limit the footprint of urban land use in the region.
- Implement Low Impact Design (ARC 2000) to minimize the adverse effects of urbanization.
- Implement riparian management in all land use classes (forestry, rural, urban).
- The greatest opportunity to enhance Auckland streams quality is in rural areas due the extent of this land use in the region and the potential for degraded rural streams to be restored.
- Full restoration of degraded rural streams is likely with improved riparian management following the Riparian Zone Management Guidelines (ARC 2001). The goal should be the establishment of native vegetation and canopy closure to shade rural stream channels.
- Urban stream will also be substantially enhanced with improved riparian management but will not achieve full protection due to poor water quality. The goal should be the establishment of native vegetation and canopy closure to shade urban streams channels.
- Forestry sites appeared to recover after harvest but recovery may take many years, and adverse effects due to sediment deposition remained.

6) Cited Literature

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