Case study

Ambient (routine) monitoring

Ecosystem Health Monitoring Program

The following case study is based on an ongoing government agency monitoring program. Although a number of the methods used would be beyond the capabilities of most community groups, several elements of this study could be used as a framework when designing a community-based monitoring program.

Background

The Ecosystem Health Monitoring Program (EHMP), South East Queensland covers an area of 22 672 km^2 that is bounded by Noosa in the north, the New South Wales border in the south and the Great Dividing Range in the west. The area includes eighteen major river catchments and supports a population of over 2.5 million people.

The EHMP is managed by the Healthy Waterways Partnership ('the partnership'), a cooperative entity involving the Queensland Government, local governments and universities, CSIRO and industry groups. A large range of experts from partnership members contribute to the operation of the EHMP.

The operating philosophy of the partnership consists of four key elements:

- continually improving the knowledge base for management
- applying adaptive management
- ensuring stakeholder involvement
- implementing at the most appropriate level within an integrated regional planning framework.

The EHMP includes both freshwater and estuarine monitoring. This case study focuses on the freshwater monitoring component undertaken by the Department of Natural Resources and Water since 2003.

Project objectives

Based on the four key operating elements, the project objectives were to:

- deliver a cost-effective and integrated regional assessment of the ecosystem health of South East Queensland waterways
- provide effective evaluation and communication of monitoring results
- assess trends using a variety of ecosystem health indicators to evaluate the effectiveness of environmental protection and management measures
- facilitate improved access to monitoring information through maintaining and enhancing a data management system
- enhance stakeholder capacity to contribute to monitoring programs.

This case study has been produced for the Waterwatch Queensland website <www.qld.waterwatch.org.au> and was originally developed as part of the *Queensland Community Waterway Monitoring Manual* (Department of Natural Resources and Water, Queensland, 2007)

Study design

The freshwater assessment divides South East Queensland into 18 subcatchments, with 127 sites spread across these subcatchments. Representative sites were chosen to provide regular spatial coverage within the study area to ensure that results would typify the health of streams within the catchment.

Each site is monitored twice a year—once in spring (pre-wet) and once in autumn (post-wet). These monitoring periods allow stream health following the drier winter months to be compared with that following the wetter summer months.

Indicators of freshwater health were selected following an extensive scientific study (Smith & Storey 2001) that trialled numerous indicators against a known disturbance gradient. The results of this study recommended five indicator types that responded well to disturbances associated with land clearing, industry, and urban development and would be suitable for the freshwater EHMP assessment. The five indicator types are:

- water chemistry measures (including water temperature, pH, dissolved oxygen and conductivity)
- nutrient cycling (a measure of ecosystem function)
- ecosystem processes (of production and respiration—a measurement of ecosystem function)
- macro-invertebrate communities (a measurement of ecosystem structure)
- fish communities (a measurement of ecosystem structure).

All five indicators are considered to be of equal importance, as each responds to different forms of disturbance and expresses information about different ecosystem attributes.

Monitoring methods

A combination of established and novel methods for measuring freshwater health is used to obtain data for each of the five key indicator types mentioned above. In total, 18 individual indices (listed below) are assessed.

Indicators of water chemistry include:

- pH
- conductivity
- water temperature
  - diel (daily) maximum temperature
  - diel temperature range
- dissolved oxygen
  - diel minimum dissolved oxygen
  - diel dissolved oxygen range.

Indicators of nutrient cycles include:

- nitrogen stable isotopes (δ15N)
- bioassay (NP:C).

Indicators of ecosystem processes include:

- algal growth (chlorophyll *a*)
- carbon cycling (δ13C)
- respiration (R24)
- gross primary production (GPP).

Indicators of macro-invertebrate community include:

- number of macro-invertebrate taxa
- *Plecoptera-Ephemoptera-Trichoptera* (PET) taxa richness
- SIGNAL score.

Indicators of fish community include:

- proportion of native species expected (PONSE)
- observed to expected species (O/E50)
- proportion of alien fish species.

Tables 1 and 2 briefly outline the methods used to monitor the macro-invertebrate and water chemistry indices. More detailed information on the methods used for these and the other three indicator types can be found in the EHMP Annual Technical Report 2004–05, downloadable from the EHMP website <http://www.ehmp.org.au>.

Table 1 Methods used to monitor chemical indicators

Indicator	**Monitoring method**
Water Temperature	A TPS WP-82Y meter with extended memory and inbuilt thermistor is used to measure temperature. The probe is placed into the stream at a depth of approximately 20 cm and temperature is logged every 10 minutes. Equipment is deployed for 24 hours, with the maximum and minimum temperatures identified and a 24-hour range calculated.
pH	A TPS WP-81 meter with pH probe is used to measure pH. The probe is lowered into the stream at a depth of approximately 20 cm, and a pH measurement is recorded once the reading stabilises.
Dissolved oxygen	A TPS WP-82Y meter with extended memory and an oxygen probe is used to measure dissolved oxygen. The probe is fitted with a recirculating pump to ensure constant water flow across the probe membrane, and is placed into the stream at a depth of approximately 20 cm. DO concentrations are logged every 10 minutes. Equipment is deployed for 24 hours, with the maximum and minimum values identified and a 24-hour range calculated.
Conductivity	Conductivity is measured with a TPS WP-81 water chemistry meter with conductivity probe. The probe is placed into the stream at a depth of approximately 20 cm and a conductivity measurement is recorded once the reading stabilises.

Table 2 Methods used to monitor macro-invertebrate indicators

Indicators	**Monitoring method**
Total taxa richness PET family richness SIGNAL score	All samples are collected from edge habitat to maintain consistency between sites and monitoring events. Macro-invertebrates are collected using a D-framed pond net, based on AUSRIVAS collection methods. The net is swept through the water several times at right angles to the bank. First sweeps dislodge bottom-dwelling fauna while the ensuing sweeps collect them from the water column. Following collection, the animals are sorted by 2 x 30-minute live picks (two people sorting the sample for 30 minutes each) using forceps and pipettes. Up to ten representatives from each taxon are collected with the exception of the family *Chironomidae*, where 30 specimens are collected. All specimens are placed in a labelled vial containing 70% alcohol for laboratory processing.

Quality assurance and quality control

A range of quality assurance and quality control measures are applied throughout the freshwater EHMP program to ensure a high quality of data. Listed below are the minimum quality procedures for water quality and macro-invertebrate monitoring. Further measures are implemented for the other indicator types used in the program.

In relation to staffing:

- project personnel have relevant tertiary qualifications and/or experience
- all field personnel are provided with appropriate training in theoretical and practical aspects associated with the project
- all personnel are made aware of and follow health and safety procedures.
- In relation to methods:
- the methods used are standardised and documented in detail
- all personnel are provided with documentation of the methods and techniques to be used (standard operating procedures).

When monitoring for conductivity and pH:

- meters are calibrated daily using a two-point calibration method (tests the meter at two different values) and all calibration results are recorded.
- the range of meter readings is checked against the expected range for the parameter, and the meter is recalibrated and retested if the reading is outside the expected range
- the meter readings are checked against what would be logical for the site, and the meter is recalibrated and retested for unexpected results.

When monitoring for 24-hour water temperature and dissolved oxygen:

- data loggers are calibrated daily and all calibration results are recorded
- range checks and logic checks are applied to data from equipment immediately prior to 24-hour deployment
- range checks and logic checks are applied to data from equipment immediately following 24-hour deployment.

When conducting macro-invertebrate assessment:

- a minimum of 10% of residues from live-picked samples processed by each individual are collected and stored
- aquatic macro-invertebrates picked by different individuals are collected and stored in different, labelled vials
- up-to-date nomenclature and taxonomic keys are maintained and used for macro-invertebrate taxa identification
- 10% of the samples processed (taxonomic identification) by each individual are checked (by an accredited person) for accuracy of identification. A TER of ≥ 90% Bray-Curtis similarity is required for identification.

In relation to data management:

- accuracy of data entry is confirmed using a double-entry procedure

- logic checks and range checks are applied to all data for unusual or unexpected results prior to storage
- all freshwater EHMP data and numeric results are stored in a secure Microsoft Access database
- copies of the database used to store data and numeric results are kept secure.

In relation to data analysis and reporting:

- the preceding year's data is reanalysed prior to analysing new data to confirm accurate operation of the computer software used for analysis
- logic checks and range checks are applied to data analysis input files immediately prior to analysis.

Data analysis

There were four key steps for the data analysis.

1. Calculate standardised scores, accounting for major spatial variation and differences in measurement scale across indices using the equation given in the report.
2. Summarise scores at various levels—for example, as per the 'Reporting' section below.
3. Create box and whisker plots to display natural variation.
4. Create ecosystem health (EcoH) plots (see Figure 1)

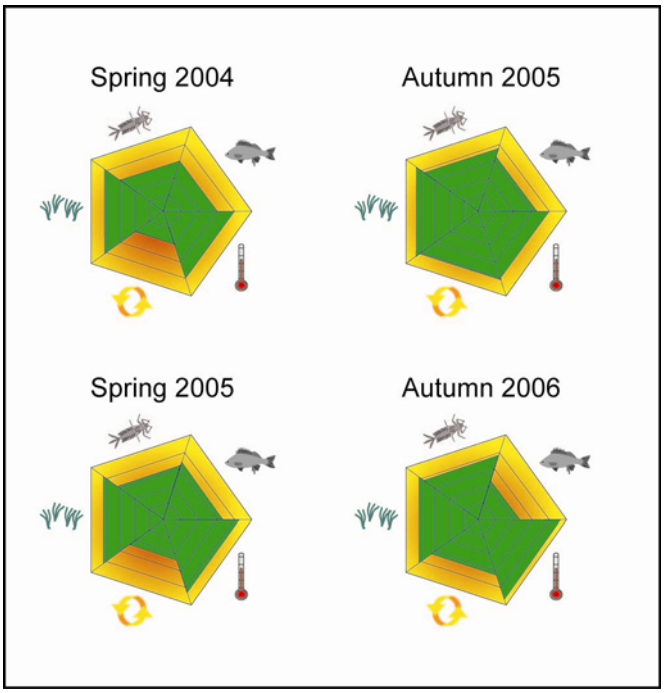

Figure 1 Examples of ecosystem health plot pentagons (reproduced with permission from the Moreton Bay Waterways and Catchments Partnership)

The EHMP data undergoes four mathematical analyses to determine catchment condition. These results are then interpreted in terms of landscape features known to influence condition, in order to separate human-influenced condition from natural state. Not all catchments are naturally the same. The data from physico-chemical and macro-invertebrate indices are combined to calculate:

- Data summary by index. These are box and whisker plots (one for each index) showing
  - amount of available data

- median score
- variability in scores
- presence of unusually high or low scores
- number of values available for each index
- condition of each reporting area in terms of each index
- degree of change in the results from the previous year

- Summary reporting area ranks. These are calculations (shown for both spring and autumn) standardised for spatial variation (regional and subregional scale)
- Ecosystem health (EcoH) plot pentagons. These are specially designed pentagons that visually summarise the results of each indicator.
  - Each wedge of an EcoH plot represents a single indicator. Results are presented by filling the wedge solid green to the value of the corresponding mean score. The spring and autumn results are presented separately
  - The area of each wedge shaded in green is the (subregion) mean score, derived from all the indices for that indicator
  - The more area of a wedge is shaded, the better the condition of that indicator.

A grade is given to each catchment using the following seven step process:

1. Spring results are compared with regional ecosystem guidelines to produce a table of 127 sites x 16 standardised scores.
2. This is converted to a table of 127 sites x 5 standardised scores by taking the average of the scores for each of the five indicator types.
3. Each site is then assigned to one of the 18 subcatchments and the average of all sites within a catchment is taken, to produce a table of 18 x 5 standardised scores.
4. Steps 1 to 3 are repeated for the autumn data to create a second 18 x 5 table of standardised scores.
5. Spring and autumn scores are averaged to produce a single 18 x 5 table.
6. The five standardised scores for each catchment are averaged to give a single overall score for each catchment.
7. These scores are then ranked from highest to lowest and report card grades are assigned using an A to F grading system.

Data interpretation

A number of resources are used to aid interpretation of the results of the above analyses. These include maps of the South East Queensland region and catchment areas showing major types of land use within the catchments, and histograms showing annual rainfall in the Sunshine Coast, Gold Coast and Brisbane River catchments.

Further information on how each measure is calculated can be obtained via the EHMP website <http://www.ehmp.org.au>.

Reporting

Two main documents are used to report results:

- annual report card—a brief, easy-to-interpret summary of annual results based on a grade (A to F) for each reporting area with salient comments. An annual report card is produced based on

results from the previous 12 months. Report card grades for 2004–05 were derived for 18 catchments using the seven-step process outlined above

- annual technical report—a detailed technical document providing sufficient information to demonstrate that data interpretation is scientifically robust

References

Ecosystem Health Monitoring Program 2006, *Ecosystem Health Monitoring Program for freshwater, estuarine and marine regions of South East Queensland: annual technical report 2004–05*, Moreton Bay Waterways and Catchments Partnership, Brisbane, viewed 21 November 2006, <http://www.ehmp.org/FileLibrary/200405_technical_report.pdf>.

Smith, MJ & Storey, AW 2001, 'Design and implementation of baseline monitoring (DIBM3): developing an Ecosystem Health Monitoring Program for rivers and streams in southeast Queensland', report to the South East Queensland Regional Water Quality Management Strategy, Brisbane.