Stream water chemistry refers to all the chemical elements that are dissolved or suspended in the water column in the form of gases, ions or nutrients (e.g. O$_2$, Ca$^{2+}$, Na$^+$, Al, Fe, N$_2$, etc). The chemical composition of stream water depends primarily on the materials originated primarily from rock weathering and soil erosion that enter the stream through run-off and leaching. Therefore, the geology of the region is a key component influencing stream water chemistry.

Other factors affecting chemical inputs to streams include rainwater and land use patterns (Allan 1995). These last two factors are notably important nowadays since acid rain, produced by air pollution, and surface runoff from agricultural areas (loaded with fertilizers and pesticides) have altered negatively stream water chemical composition. These non-point sources of water pollution are often difficult to control. Other sources of chemical pollution in streams are point-source discharges from industries and sewers, which are more easily regulated (Abel, 1996). While we might not expect our reference and impact sites to vary with respect to water chemistry, we will measure various chemical parameters to use as baseline data associated with each site, and possibly useful to interpreting our algal and invertebrate data.

Relevance to stream restoration and degradation of running waters

Chemical characteristics of freshwater systems are important attributes of the ecological niches for aquatic organisms. Consequently, any significant alteration in the stream chemical composition has the potential to change the distribution and abundance of the organisms in the system. Among these attributes some of the more important are the amount of dissolved O$_2$, pH, dissolved nutrients (N, P) and the presence of toxic metals. When a stream is affected by a disturbance (i.e. industrial or organic pollution, physical alteration) these attributes might be also altered, eliminating or reducing the abundance of certain sensitive organisms, and favoring the dominance of tolerant ones.

Besides its importance as an ecological factor, stream water chemistry is also critical for human use and consumption. Chemical indices have been widely used to assess stream water quality. However, in recent years their use has declined due to the implementation of biotic indices that give more integrated information about general stream habitat quality and aquatic ecosystem health. Nevertheless, chemical assessments are still used, principally in cases of “point-source discharge” and especially when it is necessary to identify the exact nature of a pollutant. Additionally, the measurement of water chemistry is necessary to ensure the compliance to water quality standards for water supply and for recreational or agricultural purposes.

CHEMICAL PARAMETER – TYPICAL RANGES

Conductivity (uS/cm at 20 or 25°C)

- Measure of electrical conductance of water and an approximate predictor of total dissolved ions
- Although concentration of total dissolved ions can vary considerably among headwater streams, concentrations tend to increase as one proceeds downstream.

<table>
<thead>
<tr>
<th>Type</th>
<th>Typical Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pristine</td>
<td>&lt;300 uS/cm</td>
</tr>
<tr>
<td>Drinking water</td>
<td>&lt;500 uS/cm</td>
</tr>
<tr>
<td>Agricultural</td>
<td>&lt;1000 uS/cm</td>
</tr>
</tbody>
</table>

pH (units on a logarithmic scale from 1 – 14)
• Measure of the negative log of the concentration of hydrogen ions
• Low is acidic and high is alkaline; 7 is neutral
  Stressed <4
  Suitable for biota 6.5 - 9.0
  Most productive 6.5 - 8.5
  Middle 50% US sites 7.3 - 8.1

Alkalinity (mg/L)
• The buffering capacity of the water to neutralize acids
• Buffer systems are usually composed of bicarbonate and carbonate ions that resist changes in pH that can be caused by acid additions
• Bicarbonate derives almost entirely from the weathering of carbonate minerals.
• Bicarbonate is a biologically important anion; high concentrations are reflected in measurements of alkalinity and are indicative of fertile waters
• Usually alkalinity is measured as mg/l of CaCO₃ (a common source of carbonate and bicarbonate ions)
  Poorly buffered <25
  Moderately buffered 25-75
  Highly buffered >75
  Middle 50% US sites 42-162

Hardness (mg/L)
• Hardness is determined by cations that form insoluble compounds with soap, so primarily is a measured of the amount of calcium and magnesium salts. Ca²⁺ and Mg²⁺ occur mainly in combination with carbonate ions, so hardness is also expressed as mg/L CaCO₃. For this reason people often confuse alkalinity with hardness. However, it is possible to find very high alkalinity with very little calcium or magnesium.
• Calcium is the most abundant cation in the world’s rivers and it originates almost entirely from the weathering of sedimentary carbonate rocks.
  Soft 0-75
  Moderately hard 75-150
  Hard 150-300
  Very hard > 300
  Middle 50% US sites 27-157

Ammonia- N (NH₃ – mg/L)
• Form of inorganic dissolved nitrogen preferred by most microbes and algae
  Recommended criterion for fish < 0.02
  Toxic to fish >0.20

Nitrate (NO₃ mg/L)
• Form of inorganic dissolved nitrogen that results from microbial oxidation of ammonium (nitrification)
  Undisturbed forest basin ≈ 0.1 (= 100 µg/L)
  EPA quality range ≤ 10.0
  No direct effects on fish ≤ 90.0
  Middle 50% US sites 0.20 - 0.89 (= 200 – 890 µg/L)

Phosphate (PO₄ mg/l)
• Nutrient often limiting productivity of aquatic environments
• Readily sorbed onto charged clays or organic particles
  Undisturbed forest basin  0.005-0.05 (≈ 5 – 50 µg/L)
  EPA quality limit ≤0.1 (≈ 100 µg/L)
  Middle 50% US sites  0.06 – 0.29 (≈ 60 – 290 µg/L)
  **See Table 1 from Dodds and Welch (2000) for more information.

**Dissolved oxygen (O₂ mg/L)**

  Biotic crisis  3
  Low limit in many states <4
  EPA minimum  5
  Adequate for fish >5
  Middle 50% US sites  8.7-10.5

**Sources**