Appendix A: Units of Measure, Scientific Abbreviations, Symbols, Conversions, Variables, and Equations

These abbreviations are for scientific and technical writing, and are not applicable to general style. Technical abbreviations should be used only in conjunction with a number or in a table heading; spell out most text uses not associated with a number. If your audience is nontechnical, introduce these abbreviations (spell out in full on first use and put the abbreviation beside it in parentheses) or avoid the abbreviation entirely. Most of these technical abbreviations are international standards from Système International d'Unités and the CSE manual, *Scientific Style and Format* (CSE 2006).

In scientific writing, do not add *s* to a symbol for a unit of measure. Both single and plural are indicated by use of the symbol alone.

A.1 Abbreviations, Conversions, and Symbols

Weights and Measures (English)

acre[a] (0.405 ha)	
cubic feet per second (0.0283 m^3/s)	ft^3/s
fathom[a] (1.829 m or 6 ft)	
foot (30.5 cm)	ft
gallon (3.79 L)	gal
inch[b]	in
knot (0.514 m/s)	kn
mile (1.61 km)	mi
nautical mile[c] (1,852 m or 1.852 km)	nmi
ounce (28.4 g)	oz
pound (0.454 kg or 454 g)	lb
quart (0.946 L)	qt
ton[a] (2,000 lb or 907.2 kg)	
yard (0.914 m or 91.4 cm)	yd

Prefixes

giga (10^9)	G
kilo (10^3)	k
mega (10^6)	M
milli (10^{-3})	m
micro (10^{-6})	μ
nano (10^{-9})	n

Weights and Measures (Metric)

centimeter (0.394 in)	cm
gram (0.0353 oz)	g
hectare (2.47 acres)	ha
kilogram (2.20 lb)	kg
kilometer (0.622 mi)	km
liter[d] (0.264 gal, 1.06 qt)	L
meter (1.09 yd, 3.28 ft, 39.4 in)	m
micrometer (do not use micron)	μm
millimeter (0.0394 in)	mm
milliliter	mL
tonne[e] (1,000 kg or 2,205 lb)	t

Time and Temperature

day	d
degrees Celsius[f] ([°F–32]/1.8)	°C
degrees Fahrenheit[f] ([1.8×°C]+32)	°F
degrees Kelvin[f] (K = C + 273.15)	°K
hour (spell out for 24-hour time of day)	h
minute	min
month[a]	
second	s
week[a]	
year	y

Physics and Chemistry

any atomic symbol may be used	
alternating current	ac
ampere	A
British thermal unit (1.05 J)	Btu
calories (should be converted to joules in the metric system, see *joule*)	
chemical acronyms listed in Webster's dictionary (DDT, EDTA, etc.) may be used	
direct current	dc
footcandle (0.0929 lx)	fc
hertz	Hz
hydrogen ion activity (negative log of)	pH
joule (0.239 gram-calories or 0.000948 Btu)	J
lux (10.8 fc)	lx
molar	M
mole	mol
newton	N
normal	N or n
ohm	Ω
ortho	o
para	p
pascal	Pa
parts per million (per 10^6—in the metric system, use mg/L, mg/kg, etc.)	ppm
parts per thousand (per 10^3)	ppt, ‰
siemens	S
volt	V
watt	W

Mathematics and Statistics

analysis of variance	ANOVA
approximately	~
base of natural logarithm	e
chi-square	χ^2
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval[c]	CI
correlation coefficient (multiple)[g]	R
correlation coefficient (simple)[g]	r
covariance[c]	cov
degree (angular or temperature)[f]	°
degrees of freedom	df
logarithms	
base 10	log
base x	$\log_x$
natural	ln
null hypothesis[c]	H_0
alternative hypothesis[c]	H_A
mean[c, h]	$\bar{x}$
minute (angular)	′
not significant	NS
percent	%
population size[g]	N
probability[g]	P
sample size[g]	n
significance probability[c, g]	*P-val*
standard deviation[h]	σ or s
standard error[h] (of the mean)[g]	$s_{\bar{x}}$
variance[c]	σ^2 or s^2

a No abbreviation; spell out.

b Only used with a number preceding.

c Should be introduced on first use (i.e., spell out in full on first use and insert the abbreviation beside it in parentheses), or spelled out throughout document.

d In less technical contexts the symbol is often given as a lowercase *l*. This exception only applies to this symbol, not to other metric measurements.

e Metric ton may be used instead; its abbreviation (mt) may be used, but it should be introduced.

f Close up the space when used in conjunction with numbers expressing longitude/latitude, angles, and degrees (e.g., 45°F).

g Symbol or abbreviation is italicized.

h If you prefer, you may use SE for standard error, SD for standard deviation, or *var* for variance or a unique abbreviation for mean (i.e., other than $\bar{x}$); however, these abbreviations should be introduced on first use. Note that σ is the parameter and s is the estimate.

A.2 Variables and Mathematical Symbols

Use the following symbols for common mathematical symbols:

Symbol	Meaning	Remarks	Examples
+	plus, add		
−	minus, subtract		
× or •	multiplied by, times	also shown by juxtaposition of the quantities	15*n*; 15 × 25
/; ÷	divided by	avoid xy^{-1}; our readership is not entirely technical, and this usage is not part of common language	*x*/*y* or $\frac{5}{9}$
Σ	sum		
≥	equal to or greater than		
≤	equal to or less than		
>	greater than		
<	less than		
±	plus or minus		

When used with numbers or variable symbols, set off common mathematical operators (plus, minus, times, and division) and all the equality and inequality symbols from variables and numerals with a space. When these symbols are modifying a number rather than serving as operators, close them up to the numeral or write them out.

a. Spacing of mathematical symbols

Mathematical symbols should not be used as a shorthand for words, to begin a sentence, or between two words in running text. Two or more mathematical operators should not appear side by side. Mathematical symbols in adjacent mathematical expressions should be separated by words or punctuation, because it may be difficult to tell where one expression ends and another begins.

Use:	biomass of ≤ 500 g	(*a* − 1) ≥ *y*	
	x > *y* < *z* at *a* = 0.05	*but*	when *a* >0.05
	at 50 × gravity	*but*	50× magnification
Use:	at greater than −6°F		
Avoid:	>—6°F or > —6°F		
Use:	the target zone equals the optimum plus the...		
Avoid:	the target zone = the optimum + the...		

Close spaces between quantities multiplied together.

Use: 2*xy*

Close spaces between fence brackets and the variables on either side of them:

Use: (*a* − 1)*y* (4*p* + 4bc)(1 − *a*) *a*[*x*]

b. Other number standards

A mixture of numerals and spelled-out numbers can be used to express very large numbers (millions or more).

Try to avoid using text strings of individual numbers that are separated by commas or semicolons; these constructions can cause confusion.

c. Significant digits

The correct number of significant digits should be used in reported numbers. In general, the number of digits in a reported measurement implies that the true value lies within a range, the width of which is determined by the last decimal place in the measurement. Thus, a value of 5 cm implies a range of accuracy of 1 cm whereas a value of 5.3 cm implies a range of 0.1 cm. The significant digits in a computed value should not exceed that of the value in the computation with the least number of significant digits. Thus if fish lengths were measured to the nearest centimeter, average length should also be rounded to a whole centimeter.

d. Statistical findings

Include reference to the statistical method used for all relationships explained and validated in the results section through a statistical process. When reporting the results of statistical tests state the test method, associated significance probability (preferably as an equality), and, where appropriate, the degrees of freedom.

Authors should also consider and discuss biological significance of the results. It is useful for the author to note when statistically significant results have limited biological relevance (e.g., a statistical significance value of 1 cm in fish length may not have biological significance).

e. Using mathematical terms developed by others

Special terms or names for special mathematical expressions as used or defined by an author should be cited and the terminology used should be the same as the term originally used by the author, unless variations are clearly defined and explained.

Use: We estimated potential fish production using Ryder's (1965) morphoedaphic index of yield.

A.3 Equations

Equations are sentences. The left hand side is the subject; the equal sign together with the right hand are the predicate. When you use equations, follow the same advice you have been given about how to use other kinds of sentences. First, put the equation in a paragraph with a good topic sentence that focuses the reader. Break complex ideas up into smaller parts and introduce and explain one important idea at a time. Also, because equations express a complete thought and contain a subject and a predicate, equations need appropriate punctuation. Usually, you should put the the most important idea you want the reader to remember at the end of a paragraph. For that reason, it is often a good idea to end a paragraph that introduces notation with a key equation.

When you use equations, the point is to communicate. Use equations to visually show mathematical relationships. If you, the author, cannot quickly see the key relationships in an equation, then the equation is surely too complex for someone unfamiliar with the topic, and the equation should be restated using a series of simpler equations. If you have a lot of complex notation, the reader might appreciate having the entire notation system in a single table. With or without this kind of table, it is always a good idea to remind the reader of the meaning of your notation if it has not been used within a few paragraphs. Many readers will become confused if the equation subscripts are not unique identifiers. For example, do not use i to designate fish in one equation and then to designate set in another equation. Equations should be used to help readers understand models and mathematical relationships. Do not waste your reader's time developing equations for common things that the reader already understands. Just cite commonly used statistical techniques, such as typical standard deviation equations, using standard references.

All variable names should be in italics, and units of measurements should not. In this way the reader should know that $5m$ means five times the variable named by m, and 5 m means five meters. The names of all standard statistical tests and other statistics contain variable names (for example, t-test, χ^2-distribution, P-val <0.01) and are italicized as are regression coefficients and acronyms when used as variable names.

Simple equations may be included in the text if the equation will fit legibly within the line spacing for the normal paragraph style. These equations should not be numbered. You may wish to number key equations so that you can refer back to them by name. If you number equations, place the equation number in parentheses aligned with the right margin of the page. Complex equations displayed in documents prepared with the two-column template may be formatted to print across both columns. If the equation exceeds a single column width, do not wrap text around the equations. An example of a formatted, numbered equation follows:

$$Var\left(\hat{D}_i\right)=\frac{\hat{D}_i\left(1-\hat{D}_i\right)}{n_{ti}-1}. \tag{1}$$

When typesetting an equation, take care that the symbols translate correctly when the document is submitted for review, editing, or publication.

a. Equation checklist

1. Key concepts are introduced one at a time and fully explained before introducing new concepts.
2. It is easy to see key relationships by looking at the equations.
3. Variable names are in italics.
4. Units of measurement are in regular text.
5. The equations have the correct punctuation.
6. Mathematical ideas are consistently called by one and only one name.
7. Notation is not used for more than one thing.

b. Example equation narrative

Let x_i represent the number of long-distance strays from release group i. Let y_i denote the original release size of the cohort of tagged fish of this particular release group, making no attempt to expand or otherwise account for untagged fish. We let the value of this covariate serve as a surrogate for the number of adult salmon returning from release group i. Each release group also was associated with another covariate, which we denote as z_i, which provides the shortest over-water distance from the hatchery to the release site. In cases where the fish were directly released at the hatchery, that is non-remote releases, the value of this covariate is zero.

We assumed that the number of long-distance strays detected from release group i followed a Poisson distribution, with an underlying intensity (or rate of stray detection) as function of both observed factors of interest and quantitative measures of interest. If λ_i denotes the Poisson mean of the number of freshwater recovered tags from long-distance stray fish for release group i, we assumed that the natural logarithm of this parameter can be expressed as a liner statistical model. Because we assumed that x_i follows a Poisson distribution, then we can write the probability or recovering exactly x_i tagged fish in freshwater from release group i as,

$$f(x_i \mid \lambda_i) = \frac{\lambda_i^{x_i} \exp(\lambda_i)}{x_i!} \text{, for } x_i \text{ equal to } 0, 1, 2, 3, \ldots \text{ and so on.} \qquad (1)$$

We can use Equation (1) to find that $E(x_i) = \lambda_i$. Taking logarithms we find the linear model $\ln(\lambda_i) = \mu + \alpha + \beta + \xi y_i + \delta z_i \ldots$, for y and z denoting covariates of interest and α and β representing the release-specific effects, such as hatchery or release site.