# Timescale

Encyclopedia of Estuaries
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# TIME SCALE (OR "TIMESCALE")

## Definition

Time scale refers to "the time allowed for or taken by a process or sequence of events" (OUP, 2013).

## Essential concepts, application and usage

The above definition provides a general description of the term "time scale." In science and engineering practice, a time scale is typically an *estimate* expressing a representative, overall magnitude as opposed to a precise value; as such, time scales (like length, velocity, and other commonly used scales) are frequently quantified in terms of orders of magnitude (Cushman-Roisin and Beckers, 2011). A time scale carries the dimension of time and may be expressed either in precise temporal units (e.g., seconds, hours, days, years, decades) or in approximate temporal units (as with "tidal", "seasonal", or "episodic" time scales).

In combination with other scales, time scales may be used to estimate the relative magnitude (and thus, importance) of individual terms in time-marching equations (Cushman-Roisin and Beckers, 2011). Time scales may be defined to describe the rates of physical, biological, and chemical processes, serving as a common currency with which to compare their relative speed, and thus importance (e.g., Koseff et al., 1993; Dame, 2012; Middleburg and Nieuwenhuize, 2000; Lucas et al., 2009). In such a context, a smaller time scale suggests a faster and more dominant process (Lucas, 2010). A time scale may be estimated as the reciprocal of a first order rate constant or frequency, or from a combination of length, velocity, diffusivity, or other scales such that the remaining dimension is *time* (e.g., Fischer et al., 1979; Koseff et al., 1993). A time scale may reflect the approximate time for completion of a process, such as for: diffusive mixing over an estuary's depth (Fischer et al., 1979), advective transport over the estuary length (MacCready and Banas, 2011), flushing of an estuary by river flow and/or tides (Sheldon and Alber, 2006), settling of particles through a water column (de Brauwere and Deleersnijder, 2010), biomass growth by a factor *e* (Lucas, 2010), or filtration of a water column or estuary volume by benthic organisms (Buzzelli et al., 2013).

The term "time scale" may also be used to convey: a typical period of variability or fluctuation in estuarine forcing or ecosystem response (e.g., Litaker et al., 1993; Cloern, 1996; Jay et al., 2000); a period of estuary adjustment to low-frequency forcing (e.g., Monismith et al. 2002; MacCready and Geyer, 2010); the period(s) of variability captured by measurements or models (e.g., Blumberg et al., 1999; Wang et al., 1999); or the temporal lens through which processes are examined (e.g., Stacey et al., 2001; Chapin III et al., 2006).

## Summary

Described very generally, a "time scale" is the time taken by a process or sequence of events (OUP, 2013). However, there exist many shades of meaning and usage of this term, which is ubiquitous in engineering and increasingly so in environmental science. Typically, a "time scale"

implies a time *estimate*, not a precise value. Comparison of time scales for two or more coincident processes (be they physical, biological, or chemical) provides a diagnostic tool for assessing the processes' relative importance and, potentially, for simplifying complex equations.

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**Cross References**

Residence time