Notes for Oyster Goals calculator.

NOTE: *Under GOALS we need to have separate, independent sizes for each density of oysters. In some/many instances, the bay will have zero oysters currently, but users still need to be able to enter ‘goal’ size distributions. Also, when a site loads sample data, let’s NOT have the densities automatically load the goal densities (or sizes) because the restoration goals will undoubtedly be wildly different than current for both. [I disagree with this – if we don’t provide defaults, then there’s no starting point for goal estimates. Better to start w/ current density as default,*

**BAY PROPERTIES**: Bay properties are physical parameters of the bay used to calculate filtration.

Bay Volume: This is the volume of the bay or estuary in question, in cubic meters. Volumes provided are from a NOAA compilation (Bricker et al. 2007). [Best to link to this if possible]

Residence time: Residence time is the average length of time that a parcel of water will remain in an estuary considering the tidal exchange, measured in days.

Temperature: Water temperature has a strong influence on filtration rate. The appropriate seasonal temperature should be used. Decide in advance the month or season for which estuary filtration goals are being set. [Need to state that provided values are summer avg.]

**CURRENT OYSTER PROPERTIES**: These data are used to determine the filtration provided by oysters that currently exist in the bay or estuary. If no oysters are present, then these inputs will remain empty.

Current Reef Area: This is the area, in hectares, of the oyster reef currently existing in the bay or estuary.

Mean Oyster Length (< or ≥ 76mm): Filtration estimates will be more accurate if calculated for convenient size categories. If data only exists for one average population size, only enter size and density data in one of the size classes. Leave the other blank. [I’m afraid adding this wordy label will really cruft things up]

Mean Oyster Density (< or ≥ 76mm): This is the average density of oysters per size category (oysters per square meter). If data are only available for one average population density, enter the size and density data in one of the size classes and leave the other blank.

**GOALS**: Data inputs that will be used to calculate the added filtration benefits from restored oyster habitat.

Estuary Filtration Percent: Changing this value (by either sliding the bar or entering a percentage) will alter the New Reef Habitat Required to achieve the Filtration Goal given the current and goal oyster population characteristics provided.

**Need to ADD:** Mean Oyster Length, less than 76mm:

**Need to ADD:** Mean Oyster Length, greater than 76mm:

Mean Oyster Length (< or ≥ 76mm). This is expected average size of oysters in restored areas in the size category ((< or ≥ 76mm).

Mean Oyster Density (< or ≥ 76mm): This is expected average density of oysters in restored areas in the size category (< or ≥ 76mm).

**BAY FILTRATION**: This section displays the filtration outputs, in litres of water filtered per hour, given the data that has been supplied. [This is not liters per hour. It is volume of water filtered within residence time]

Estuary Filter Volume: This is the rate of filtration required to achieve full estuary filtration. It is calculated by dividing the bay volume by the residency time and converting the output to litres per hour. [Not L/hr]

Historic Filtration: This is a reference of historical filtration value for a given bay or estuary where the historic oyster data are available (percent filtration of estuary filter volume in litres per hour). It is not used in calculating current day filtration or restoration goals and only meant to be used as a historical reference (zu Ermgassen et al. 2012). [Again, not L/hr]

Current filtration: This is an estimate of the current filtration based on the data inputs provided (Current Oyster Properties). It is displayed as percent filtration of the Estuary filter volume in litres per hour.

Goal filtration: This is the required filtration, in litres per hour, required that you seek to provide through restored oyster habitat.

New Reef Habitat Required (**NEED TO ADD THE WORD ‘REQUIRED’)** This is the amount of restored oyster habitat, given the expected size and density of restored oysters, required to achieve the desired amount of filtration specified.

Need to, specify the units under Bay Filtration as l Hr-1 B L Hr-1 or M L Hr-1 . Alternatively add a parenthesis number in the Residence Time box under Bay Properties that converts days to hours to indicate that is what is used in the calculation. [Again, calculations follow practitioner’s guide, which doesn’t calculate per hour.]

**Here’s some general language that we’ll want to put on the page above the calculator for some background. (Could use abbreviating).**

Oysters are filter feeding bivalves. By removing small particles from the water column and ejecting them as larger faeces or pseudofaeces, oysters can improve water clarity. The volume of water cleared by an oyster is determined by the species, the size of the oyster, the temperature, the sediment load, and salinity. The potential for oyster filtration to have a marked effect on water clarity is therefore dependent both on the abundance of oysters and on local conditions. This application to estimate water filtration provided by oysters uses the equations derived by zu Ermgassen et al. (2012a & 2012b), which is fitted to data collected on oyster reefs *in situ* for eastern oysters and from lab studies for Olympia oysters. Population level filtration can be estimated with as little information as mean oyster size, density and water temperature.

Restoration objectives can be set on a number of scales. A small scale objective can be established with the aim of restoring an oyster population capable of filtering a given volume of water at a given time of year. Water temperature has a strong influence on filtration rate. The appropriate seasonal temperature should therefore be used in this calculation. Where possible temperature at the restoration site should be used to derive estimates of volume filtered.

Larger scale objectives can be set on the basis of achieving full estuary filtration, and should, form the long term objective for many smaller restoration projects and may be appropriate for smaller restoration efforts in more contained settings, such as a creek. Estimating the degree of restoration necessary to achieve full estuary filtration relies on knowledge of the residence time of the water in the estuary. Full estuary filtration is defined as “filtering a volume equivalent or larger than the entire estuary volume within the residence time of the water”. Full estuary filtration does not actually equate to complete filtration of all estuarine waters as this rough calculation assumes that the estuary is perfectly mixed, which is never the case. Furthermore, it does not account for phytoplankton production. Full estuary filtration nevertheless provides a useful indicator of the rate of filtration relative to tidal exchange, which in turn is an indicator of the potential for filtration to have a large scale impact on the ecology of the estuary . It should be noted that increasing oyster populations to the point at which they achieve full estuary filtration is unlikely to resolve the water quality concerns of many US estuaries on its own, but could meaningfully contribute to a system wide approach.

This application will yield the total volume that needs to be filtered within a 24 hour period in order to achieve full estuary filtration. This volume can be achieved by a) increasing the area of oyster reef, b) increasing the density of oysters or c) increasing the mean size of oysters. Options a and b will yield far greater returns as regards total filtration than option c. To set an objective, one can use either the known or expected density of oysters on the restored site to calculate the volume filtered per unit area, then divide the total volume of the estuary by the calculated volume filtered per unit area to get an estimate of the required area of restoration. Or one can assume a fixed area of oyster reef and determine what the target density should be in order to achieve full estuary filtration. In either case it is necessary to decide in advance in which season full estuary filtration is most desirable. The season or monthly average temperature can then be used.

The volume of water that passes through (is filtered by) oysters does not equal the volume of water cleared of particles. Oysters do not filter efficiently across all size classes, and their efficiency can vary under suboptimal conditions, such as high sediment loads. As the filtration rates estimated here are derived from the volume of water cleared *in situ* it can, however, be used as a good estimate of the potential volume of water cleared. However, particles may become resuspended by water movement and wave action so it cannot be assumed that full estuary filtration will result in clear water across the whole of the bay or estuary. This approach nevertheless provides a conceptual framework for estimating when a system-wide effect may be expected, and hence how much restoration may be necessary to see large scale impacts on water clarity.