STANDARD OPERATING PROCEDURE

Measurement of Greenhouse Gas Fluxes from Shrimp Farms Using Floating Chambers

Version	1.0	**Date of Issue**	03/12/2025
Purposes	This Standard Operating Procedure (SOP) displays the floating chamber-based method for measurement of greenhouse gas fluxes from shrimp farms and inland waters, including ponds, lakes, rivers, and wetlands. With relatively modest infrastructure investments, measurement may be attained from multiple treatments/locations and over timeframes ranging from hours to days.		
Scope	The floating chamber method is a low-cost and simple method frequently used to measure gas fluxes from shrimp farms. This method has a capacity to obtain point measurements in a short time which enables studies to cover a better spatial resolution with higher mobility of measurements. In particular, by using multiple floating chambers at once, this measurement can monitor GHG emissions to site scale (up to few tenths of a square meter). Temporal resolution of floating chambers can range typically from 20 to 60 min, but can go up to 24 hours depending on the margin of the fluxes.		
Requirements	Some required info needs to be defined before the measurement: • Define measured gases • Define measured waterbody • Define estimation method • Define sites of interest, including spatial resolution of measurements and number • Define timeframe of measurements		
Related documents	1. IHA, *GHG Measurement Guidelines for Freshwater Reservoirs: Derived from: the UNESCO/IHA Greenhouse Gas Emissions from Freshwater Reservoirs Research Project*. 2010: International Hydropower Association (IHA). 2. Eggleston, H., et al., *2006 IPCC guidelines for national greenhouse gas inventories.* 2006. 3. APHA, *Standard methods for the examination of water and wastewater.* American Public Health Association (APHA): Washington, DC, USA, 2005.		

Procedure

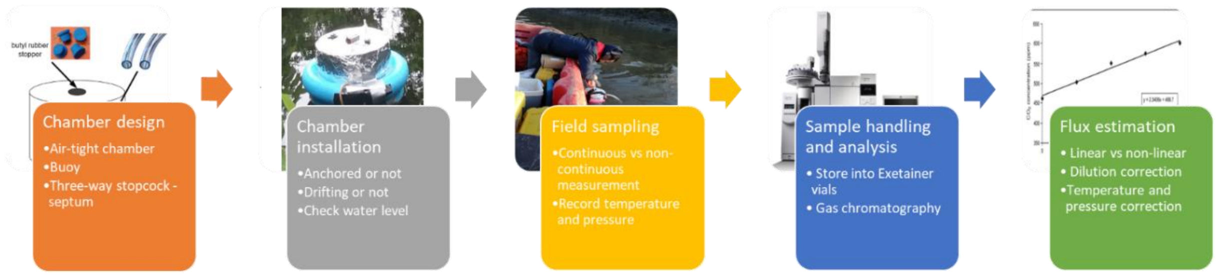

Figure 1. Measurement procedure of greenhouse gas fluxes from shrimp farms using floating chambers

Step 1: Chamber design	Chamber design can vary but should satisfy the following criteria. Basically, a chamber must be an air-tight box that can float on the water. The volume of headspace must be calculable for flux estimation. It is unnecessary to weight the base of the chambers; however, if strong waves are likely, then weighting becomes mandatory [1]. It is advisable to cover the chamber with aluminum foil or Mylar paper to prevent overheating inside the chamber during the deployment period. To collect gas samples, a butyl rubber stopper or a three-way stopcock or a Tygon tubing should be embedded on top of the floating chambers. A vent must be installed on the top of the floating chamber to equalize the air pressure in the chamber with the atmospheric pressure before starting the measurements.
Step 2: Chamber installation	In the field, one or multiple floating chambers can be placed at a distance of about 2 m from each other. The floating chambers are placed upside down for a few minutes to allow equilibration with local air. The chambers are then placed on the water from 20 to 60 min, but can go up to 24 hours depending on the margin of the fluxes. Note that the chambers can be deployed anchored or freely drifting with the water. While drifting chambers will create less turbulence in the surface water, they can travel far during the deployment periods which results in spatially biased measurement and logistical challenges. Equally important is that the use of anchored chambers in shallow waters can also disturb sediment layers, leading to excess ebullition events.
Step 3: Field sampling	For the conventional floating chambers, gases can be collected into an Exetainer vial via butyl rubber stopper or three-way stopcock or Tygon tubing embedded on top of the floating chambers. Note that the Exetainer vials should be flushed several times with inert gas, such as helium (He) or nitrogen (N_2), and vacuumed in the end. Several gas samples, from three to five, should be collected in same time intervals, such as 0, 15, 30, 45, 60 minutes. These intervals should be defined based on the margin of the fluxes. They should be sufficiently long to obtain distinctive difference of gas concentrations in the headspace, but sufficiently short to avoid oversaturation of gas concentrations in the headspace. Given their short-term incubation time, it is likely that episodic ebullition events or diel variability cannot be captured in a precise manner by floating chambers while longer deployment time can increase the risk of gas dissolution and oxidation [2]. To avoid these issues, automated floating chambers were developed using mini-

loggers to continuously measure gas concentrations while applying air pump and valve system to ventilate headspace and passively regulate excess air pressure.

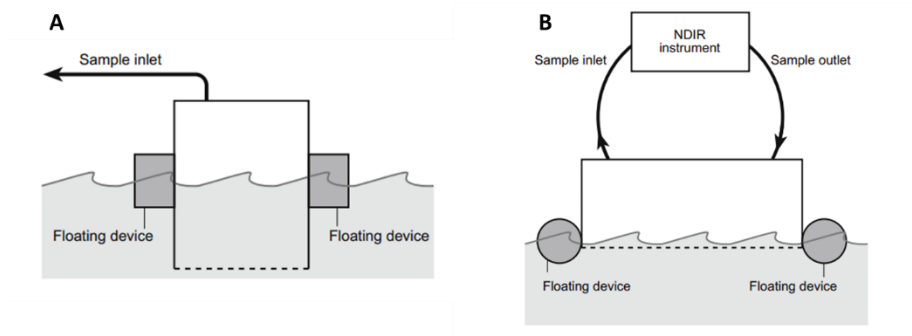

Figure 2. Design of floating chambers with: A) Conventional; B) Automated instrument. (adapted from [3])

Step 4: Sample analysis	Exetainer vials with collected gas samples should be measured in the lab following the guideline of APHA [4]. Details of the standard methods for gas analysis measurement, including volumetric and gas chromatographic methods, can be found in this guideline.

Step 5: Flux estimation

Gas concentrations collected in same time intervals allow the calculation of a flux by linear regression (Figure 3).

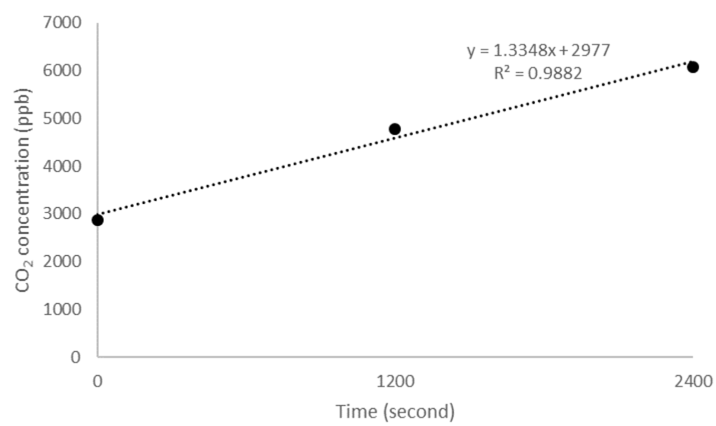

Figure 3. Typical graph of greenhouse gas concentrations over times.

In contrast to a widespread assumption about the linear increase of diffusive fluxes from water and shrimp farm systems, the gas exchange may be fluctuated over time because of the non-steady-state conditions of floating chambers and the natural processes occurring in the waterbodies [5]. Because of these v, it was reported that chamber-measured fluxes were underestimated by 10-50% when using linear models for estimation [5, 6]. To deal with the biases, Kutzbach, Schneider [6] proposed an exponential model for the estimation of CO_2 fluxes while Pedersen, Petersen [7] also developed theoretical exponential model for N_2O fluxes estimation across soil-air interfaces. Given their more accurate estimation, the quadratic and exponential models were highly recommended as a better alternative for linear models [5]; however, these studies remain empirical and lack theoretical basis [8].

	As such, it is advisable for researchers to test both linear and non-linear models on the collected data while keeping in mind the other uncertainty sources during the design and implementation processes of the sampling campaigns.

Quality management	
QA / QC procedures	Flux estimation by floating chambers appears to be subject to following uncertainties: (1) determination of headspace volume and cross sectional area, (2) temperature and concentration gradient changes during the deployment, (3) dilution factor of artificial water vapor accumulation, (4) additional turbulence around the chamber edges, (5) lack of mixing within the headspace, (6) irregular eruptions of gas accumulated in the sediment [5, 6, 9-11].

Version Log

Version	Authors	Material changes from previous version	Release Date
1.0	Long Ho	Initial version	20-12-2025

Bibliography

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