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# Updated development and performance of the NISURI Fast-Set system in Ecuadorian artisanal demersal longline fisheries: operational advances and time-depth recorder evidence

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**SUMMARY**

Seabird bycatch in artisanal longline fisheries represents a significant conservation concern along the Ecuadorian coast, where several threatened and ACAP-listed species forage. Effective mitigation in this sector must be affordable, operationally practical, and acceptable to fishers. The NISURI Fast-Set system was developed to meet these requirements, for artisanal demersal longlines, by enabling rapid deployment of baited hooks while reducing seabird access to hooks near the surface. This report describes recent updates to the system, including the development of a new three-tube configuration, and evaluates its sink performance using time-depth recorders (TDR) data. TDR trials conducted in 2019 compared conventional demersal longline setting with the NISURI system. Results indicated that, when paired with 600 g weights, the NISURI system generally improved initial sink performance, particularly within the first 1–2 m of the water column. The system is a low-cost, practical mitigation measure with potential to reduce seabird bycatch, improve crew safety, and enhance fishing efficiency in artisanal demersal longline fisheries.

## 1. INTRODUCTION

Seabird bycatch in fisheries is a major threat to seabird populations worldwide, particularly among Procellariiformes (Clay *et al.* 2019; Jiménez *et al.* 2014; Rodríguez *et al.* 2017) . The Ecuadorian coast forms part of the foraging range of several pelagic seabird species, including threatened and ACAP-listed taxa such as the Waved Albatross (*Phoebastria irrorate*), Black Petrel (*Procellaria parkinsoni*), White-chinned Petrel (*Procellaria aequinoctialis*), Pink-footed Shearwater (*Ardena creatopus*), and Salvin's Albatross (*Thalassarche salvini*). Seabird bycatch has been documented in Ecuadorian fisheries, including in the artisanal sector, with most reported records associated with artisanal longline operations (Awkerman *et al.* 2006; Jiménez-Uzcátegui *et al.* n.d.; Reyes *et al.* 2024; Rowley *et al.* 2025.) .

Seabird bycatch occurs in both industrial and artisanal fisheries (Clay *et al.* 2019; Votier *et al.* 2023) . Although bycatch mitigation in industrial fleets can be operationally complex, these fisheries are comparatively easier to regulate, monitor, and enforce, and are more likely to have the financial capacity to adopt mitigation measures. In contrast, artisanal fisheries are typically associated with small-scale and economically vulnerable coastal communities(Júnior *et al.* 2016). In Ecuador, approximately 28,500 artisanal fishers are officially registered, although this is widely considered an underestimate and the true number may be closer to 50,000 (Peñaherrera-Palma *et al.* 2025) . Collectively, these fisheries are of major social and economic importance, contributing to food security and harvesting substantial quantities of marine resources each year. However, they are difficult to regulate and monitor because vessels are small, usually operate with limited capacity to invest in additional mitigation equipment (Júnior *et al.* 2016) .

In this context, an effective mitigation measure for artisanal fisheries must meet three basic criteria: (1) it must be affordable, (2) it must maintain or improve target catch performance, and (3) it must effectively reduce or eliminate seabird bycatch. Few mitigation measures satisfy all three requirements simultaneously, and the NISURI Fast-Set system was developed as an attempt to address this need in Ecuadorian artisanal demersal longline fisheries. Developed by Giovanny Suárez and Nigel Brothers, the system originated from a single PVC-tube prototype first presented in 2014 and was subsequently refined through continued testing with artisanal fishers (Suarez & Wallace 2023). This process led to a double and a more recent triple-tube design supported by a steel structure attached to the gunwale of the vessel. The system was developed to provide a simple, low-cost, and fisher-acceptable method for rapidly deploying baited hooks, while reducing seabird access to hooks near the surface and improving crew safety by reducing direct hook handling during deployment.

The aim of this report is to describe recent updates to the NISURI system and to present a time-depth recorder (TDR)-based evaluation of its sink performance relative to traditional hook-setting methods.

### 1.1. Development of the updated NISURI Fast-set system

The NISURI Fast-Set system was developed through an iterative design process to produce a practical bycatch-mitigation tool for artisanal demersal longline fisheries. Early versions consisted of a single PVC-tube device designed to accelerate the deployment of baited hooks (up to 300 hooks) and thereby reduce the time hooks remained accessible to seabirds near the surface. Subsequent testing led to refinements that improved onboard stability and carrying capacity (Suarez & Wallace 2023). However, fishers requested a system capable of deploying 600 hooks, reflecting an increase in the number of hooks commonly used during fishing operations. This led to the development of the double-tube configuration, which retained the operating principle of the original design while incorporating a second tube and an improved metal support structure mounted to the vessel (Suarez & Wallace 2023).

For the system to operate effectively, deployment required the use of 600 g concrete weights every 30-35 hooks. In the double-tube configuration, however, these weights still had to be released manually during the line set. More recently, fishers expressed interest in a fully automated version that could be operated by a single person, allowing the vessel operator to deploy the system without handling the weights separately. In response, a three-tube configuration was developed. In the latest version of the system the third tube carries a total of 18 weights, which enter the water together with the baited hooks. This modification eliminates the need for manual weight deployment during line setting, as was required in the two-tube system.

### 1.2. Materials and Construction

The current NISURI system is constructed primarily from PVC tubing and steel components (Suarez & Wallace 2023). The 3-tube configuration utilises 5 PVC tubes: two main tubes measuring 2.40 m in length and two base tubes of 2.30 m. These base tubes are cut lengthwise and joined to overlap one another, forming the hook-loading and ejection channels with a third 2.40m tube for the weights that has a 4mm grove cut to accommodate line to weights (See Photo 1).  The three tubes are arranged in a triangular configuration, with two tubes for hooks mounted over and under, and the weights tube positioned centrally below them.

A steel mounting structure enables the system to be securely attached to the side of the vessel. Steel support plates are positioned along the gunwale at intervals of roughly 1 m, and the tube assembly is bolted onto these plates. The metal structure holds the hook setting tubes and the weight release tube. This support structure is specifically adapted for artisanal vessels, particularly wooden boats coated with fibreglass, with steel brackets and bolts ensuring the tubes remain stable during transport and deployment. The mounting arrangement also permits the system to be easily removed. The current approximate cost for materials and manufacturing of a complete 3-tube NISURI Fast-Set system in Ecuador is approximately $70.

### 1.3. Operational deployment

Hooks are baited with pieces of fish or squid measuring 10 – 15 cm, selected according to target species. Prior to loading, the tubes are wetted with seawater to prevent the bait from adhering to the tube surfaces. Baited hooks are inserted sequentially, starting from the last to the first hook line in the mother line, with the bottom tube loaded first followed by the top tube. Careful attention is required to avoid entanglement of the leader nylon line during loading. The mainline is kept organised in a crate beneath the system, on the floor of the vessel. Each tube accommodates 300 hooks (sizes 10–11), resulting in a maximum system capacity of approximately 600 hooks. The third tube carries the weights, which also must be loaded sequentially with the hooks for safe operation.

Once all hooks are loaded, the system is positioned at a 30-degree angle outward from the vessel hull and secured on the metal mounting plate. The deployment begins with the release of the first buoy carrying a signalling flag and the mother line weight, followed by accelerating the vessel to a speed of 10–15 knots. The vessel’s forward motion enables the hooks and bait to slide smoothly through the tubes and into the water. The release rate is approximately three baited hooks per second, allowing up to 600 hooks and 18 weights to be deployed within 3–4 minutes.

### 1.4. Line weights

To ensure rapid sink rates of the longline and baited hooks, the NISURI system should be used in combination with line weights. The system performed most effectively when paired with 600 g weights attached to the mainline, which promote rapid sinking after deployment. Weights are attached to the mother line at 20 m intervals, equivalent to approximately one weight per 30–35 hooks. Each weight was manufactured from a concrete mixture of sand, water, and cement, cast in a plastic mould made from 2-inch PVC tubing cut to a height of 25 cm. A cable and swivel were embedded within each weight during casting. In Ecuador, the approximate production cost was US$0.45 per weight.

## 2. METHODS

Time-depth recorder (TDR) trials using the CEFAS Technology model G5-ST, were conducted in 2019 to assess the sink performance of artisanal demersal longlines under conventional settings and when deployed with the NISURI system equipped with manufactured concrete weights. TDRs were affixed to the beginning, middle, and end sections of the longline to analyse sink behaviour across different positions along the gear. Trials were carried out using lines with 300, 500 and 600 hooks, while NISURI-equipped longlines were tested with weights of 450, and 900 grams to evaluate their effect on sinking rates. A total of 21 tests were completed during the study period. Depth records collected by the TDRs were used to generate depth-time profiles and to evaluate the descent of the line through the upper water column, with particular focus on the initial sinking phase when baited hooks are most at risk of seabird interactions.

Sink performance was summarized by calculating the average time required to reach fixed depth thresholds of 1, 2, 3, 5, and 10 m for each treatment block. Mean values were derived from the available individual TDR records within each treatment, with missing values excluded from the calculations. These depth-specific means provided a standardized basis for comparing treatments. Because the spreadsheet summarizes discrete time-to-depth observations, the resulting averages should be interpreted as mean descent times to fixed depths rather than as continuous sink-rate trajectories. Data handling and summary calculations were conducted in R, including estimation of mean descent times and comparative sink-performance metrics among treatments.

## 3. RESULTS AND DISCUSSION

The NISURI fast-set system represents a low-cost mitigation measure for artisanal demersal longline fisheries. In Ecuador, the approximate cost of the complete system, including weights, is less than US$100, making it financially accessible for small-scale fishers. The device is constructed from materials that are readily available in local hardware stores, and its manufacture is relatively simple and does not require specialized tools. These characteristics increase its potential for uptake and adaptation in other artisanal fisheries using demersal longline beyond Ecuador.

Fishers reported that the NISURI system does not reduce catch. On the contrary, its rapid deployment may improve operational efficiency by allowing more sets to be completed within a fishing day. A traditional demersal longline set deployed manually can take up to 1 h to complete, whereas line setting with NISURI takes less than 5 min. Loading the system before deployment requires approximately 20 min for an experienced fisher, but this additional preparation time is offset by the substantial reduction in setting time at sea.

The system also provides important safety benefits. Because fishers do not need to handle baited hooks directly during line setting, the risk of entanglement and accidental hooking is greatly reduced. This safety advantage is further enhanced in the three-tube configuration, in which the weights are deployed through a third tube and no longer need to be handled manually during setting.

Time-depth recorder data indicated that the NISURI system, when paired with 600 g weights attached to the mother line, generally improved sink performance relative to traditional line setting, particularly within the first 1–2 m of the water column (Fig 1). With the 600 g treatment, the traditional system averaged 15.7 s to reach 1 m and 26.3 s to reach 2 m, whereas one NISURI treatment averaged 6.8 s to 1 m and 13.5 s to 2 m. At greater depths, differences between treatments were less consistent, suggesting that the principal advantage of NISURI lies in improving the initial phase of sinking rather than producing uniformly faster descent throughout the full water column.

Variation among deployments was substantial, indicating that sink performance is also influenced by other factors, including vessel speed, sea conditions, and gear configuration. In addition, the TDR trials presented here used the two-tube NISURI system, and the comparison with traditional gear should be interpreted cautiously because the traditional treatment was also paired with 600 g weights. This does not fully reflect current artisanal demersal longline practice in Ecuador, where fishers commonly use stones or plastic bottles filled with sand as weights. These traditional weight types are less effective at promoting rapid sink rates and, in the case of plastic bottles, contribute to marine pollution and line loss. Further trials are therefore needed to isolate the effect of the NISURI system itself, independently of line weighting, and to compare it against fully traditional gear configurations currently used in the fishery.

The development of the three-tube configuration was initiated by fisher feedback and requests. Traditionally, the two-tube system required two people to operate: one to steer the vessel and another to release the weights manually. The three-tube system incorporates a third tube dedicated to the weights, allowing hooks and weights to enter the water simultaneously. This design shows promise as a more automated and safer system that can be operated by a single fisher while maintaining the rapid deployment rate. Rapid deployment is a central feature of the NISURI concept, as it reduces the period during which seabirds can detect and seize baited hooks near the surface. Overall, the results support the conclusion that the NISURI system can improve early sink performance, increase operational efficiency, and reduce safety risks to fishers, while remaining inexpensive and simple to construct. Additional trials under standardized conditions are needed to quantify its performance more robustly and to evaluate the effectiveness of the three-tube prototype under routine fishing operations.

## 4. FIGURES

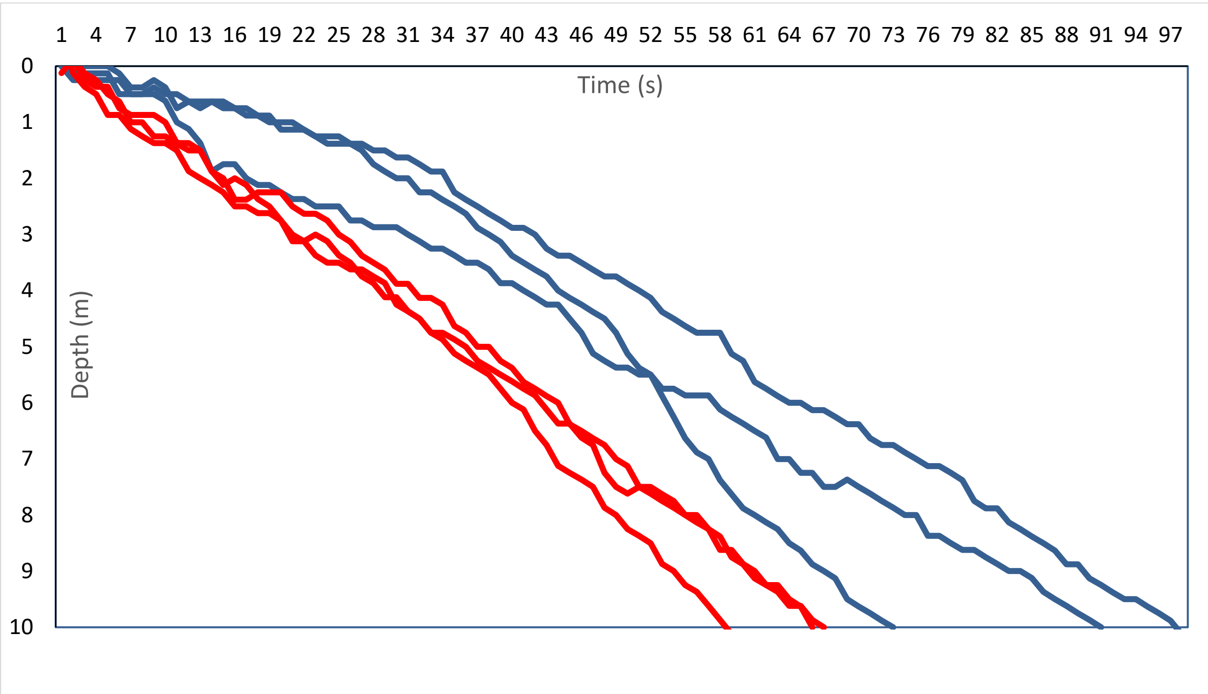


Figure 1. Time/Depth profiles of demersal longlines with 600gr weights using the traditional manual line setting (dark blue) and NISURI Fast-Set system (red).

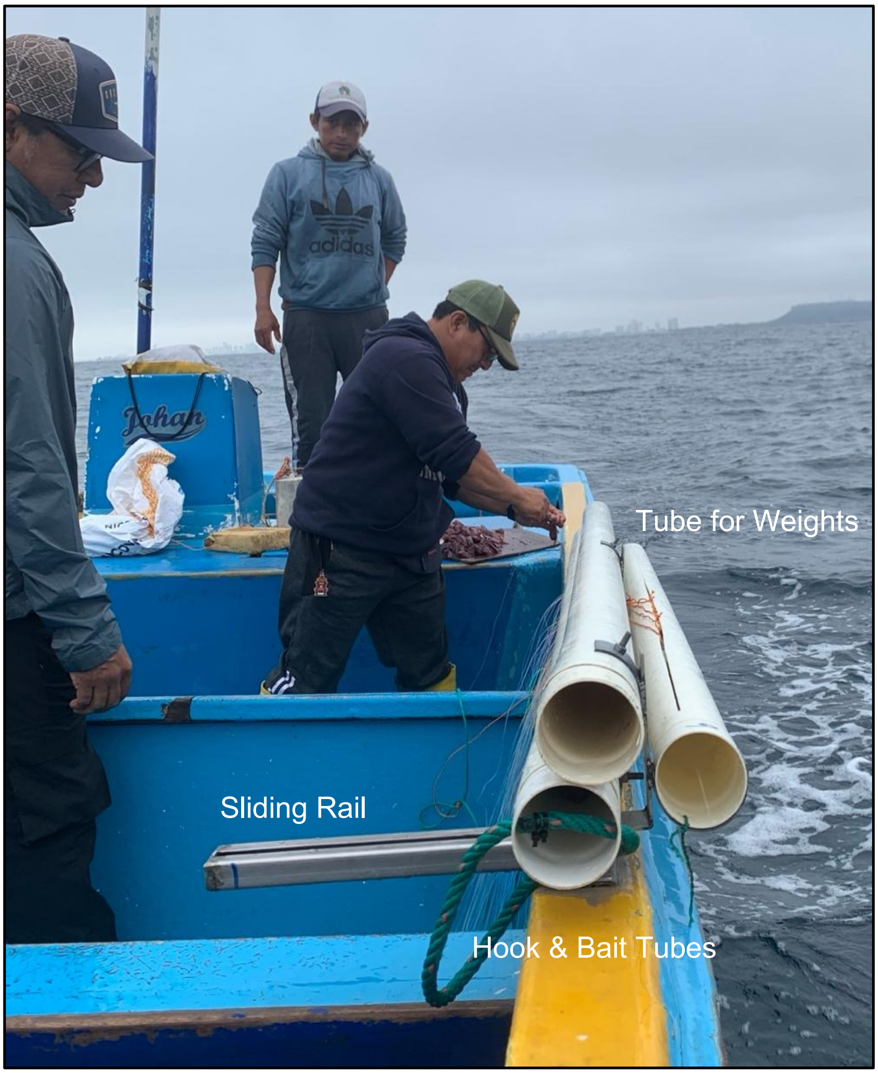


Photo 1. The 3-tube NISURI Fast-Set system installed on the gunwale of an artisanal vessel in Ecuador. Note the Sliding rail that is used to angle the system outwards from the vessel for line setting. Also note the third tube positioned to carry up to 18 concrete weights.

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