Quantifying potential of the IMAS Timed-Swim program to detect change in stock levels: AIRF Milestone Report

AIRF Milestone #3 (1/09/2024): Completion of greenlip surveys post north-east region greenlip closure.

Jaime McAllister

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## Overall Progress

Milestone 3 (Due: 1/09/2024): Completion of greenlip surveys post north-east region greenlip closure

(Status: COMPLETED).

Post season re-surveys commenced the day after the greenlip fishery closed within the North-East Greenlip fishing region on Wednesday, 3rd July. Due to poor weather conditions the re-survey of all 86 pre-season sites was not possible. However, the IMAS Dive Fisheries Team managed to re-survey 62 sites over five suitable days between July and September 2024 ([Figure 1](#fig-site-map)). Despite efforts to re-survey the remaining 24 sites, suitable conditions had not eventuated by October 1st (90 days post-closure). Given that the aim of this experiment was to minimise the duration between pre- and post-season surveys, it was decided that extending the survey period beyond this timeframe could introduce additional sources of variance or bias in the count numbers.

A preliminary examination of post-season counts indicated no significant difference in the count variation between pre- and post-surveys conducted up to 85 days apart ([Figure 2](#fig-count-diff)). Many of the remaining sites had low to zero pre-season counts for both size classes ([Table 1](#tbl-pre-post-count)) therefore extending the re-survey period to include these sites may have introduced increased bias from an already low base count, particularly due to the movement of abalone into these areas and possible natural mortality with increased time.

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| Figure 1: Map of pre-season survey sites (red) and those re-surveyed post-season (blue) in the north-east greenlip fishery region. |

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| Figure 2: A) Mean count difference between pre- and post-season greenlip abalone counts for sites on each re-survey trip, and B) Boxplot of the count differences grouped into the approximate mid-point of each post-season sampling trip conducted over a duration of 3-4 days after 4th July 2024 (season closed) (i.e. 10, 45 and 85 days post-season) in the north-east greenlip fishery region. Note: All pre-season sampling occurred prior to 1st July 2024. |

## Preliminary analysis

The primary aim of this project is to define the potential for the Timed Swim method to reliably assess changes in stock status in key areas of the fishery. We want to know if the Timed Swim method gives a reliable estimate of abundance at a particular point in time. In the absence of knowing what the true stock abundance is the best way to determine the reliability of a method is to compare repeatability over time. In other words how repeatable are counts and does the abundance at time A equal that of time B?

Over the short term we expect the correlation in sub-legal abundance between surveys to be high as they are not subject to fishing and there should be limited natural effects on their abundance (e.g. natural mortality and movement). As the duration between surveys increases we expect the correlation to weaken due factors such as movement and recruitment over the longer term. Similarly, this relationship is expected to breakdown when fishing pressure is applied to legals.

Preliminary analysis indicates a strong overall correlation between pre- and post-season counts for sub-legal greenlip at each site ([Figure 3](#fig-corr)), and among blocks ([Figure 4](#fig-corr_block)). This consistency in counts implies that natural mortality, growth in size classes (modal progression), and local movement cause minimal changes in sub-legal abundance between sampling periods. Therefore, in the absence of fishing mortality and significant natural mortality or movement, the Timed Swim method appears reliable for monitoring abundance over the short term (2-3 months).

In contrast, the relationship between pre- and post-season legal counts at each site was minimal to non-existent ([Figure 3](#fig-corr); [Figure 4](#fig-corr_block)). The overall trend shows a general decline in post-season counts, indicating that fishing pressure disrupts the relationship, which is consistent with expectation. Assuming limited natural mortality, modal progression of sub-legal abalone, and movement, the breakdown in the relationship appears primarily due to fishing mortality. This is particularly evident at sites with high pre-season counts in Block 39 ([Figure 4](#fig-corr_block)), further supporting the reliability of the Timed Swim method in detecting changes in abundance as a result of short-term fishing depletion.

These results are a strong indicator the Timed Swim method provides a reliable estimate of abundance at a particular point in time.

## Summary and Future directions

The project is progressing well and all fieldwork is now complete. Preliminary analysis has demonstrated the reliability of the Timed Swim method for detecting change in abundance. Further analysis will now start to explore the use of Type III regression to examine the influence of survey methodology on the relationships in more detail (e.g. the effect of diver ID, spatial overlap in re-survey habitat, etc). This may be of particular importance for legal abundance counts where there are some weak correlations that may not be explained by the effects of fishing or other sources of natural mortality/movement.

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| Figure 3: Relationship between pre-season and post-season legal (>150 mm) and sub-legal (<150 mm) greenlip abalone counts at each site surveyed in the north-east greenlip fishery region as of 1st September 2024 (n = 62). |

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| Figure 4: Relationship between pre-season and post-season (A) legal (>150 mm) and (B) sub-legal (<150 mm) greenlip abalone counts at each site surveyed in the north-east greenlip fishery region as of 1st September 2024 (n = 62). Blue = Block 31; Red = Block 39. |

## Appendicies

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| Table 1: Total count of sub-legal (<150 mm) and legal (>150 mm) greenlip abalone counted at each site in the north-east greenlip fishery region, pre- and post-season within Block. Pre-rank = order of sites from highest to lowest counts in pre-season survey. NS = not re-surveyed.   | Pre-rank |  | Block 31 | | |  | Block 39 | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | Site | Pre | Post |  | Site | Pre | Post | | 1 |  | GL-2023-31-33 | 146.0 | 203 |  | GL-2023-39-29 | 258.0 | 237 | | 2 |  | GL-2023-31-139 | 134.0 | NS |  | GL-2023-39-142 | 196.0 | 154 | | 3 |  | GL-2023-31-31 | 117.0 | 76 |  | GL-2023-39-64 | 147.0 | 183 | | 4 |  | GL-2023-31-131 | 107.0 | 102 |  | GL-2023-39-143 | 136.0 | 85 | | 5 |  | GL-2023-31-38 | 99.0 | 93 |  | GL-2023-39-54 | 133.0 | 201 | | 6 |  | GL-2023-31-16 | 98.0 | 75 |  | GL-2023-39-63 | 100.0 | 110 | | 7 |  | GL-2023-31-134 | 87.0 | 196 |  | GL-2023-39-79 | 99.0 | 185 | | 8 |  | GL-2023-31-39 | 84.0 | 57 |  | GL-2023-39-133 | 98.0 | 93 | | 9 |  | GL-2023-31-23 | 80.0 | 70 |  | GL-2023-39-78 | 94.0 | 87 | | 10 |  | GL-2023-31-97 | 66.0 | 68 |  | GL-2023-39-129 | 82.0 | 136 | | 11 |  | GL-2023-31-58 | 58.0 | 51 |  | GL-2023-39-24 | 72.0 | 21 | | 12 |  | GL-2023-31-83 | 58.0 | 25 |  | GL-2023-39-61 | 70.0 | 47 | | 13 |  | GL-2023-31-140 | 56.0 | 116 |  | GL-2023-39-30 | 64.0 | 44 | | 14 |  | GL-2023-31-32 | 40.0 | 34 |  | GL-2023-39-52 | 64.0 | 113 | | 15 |  | GL-2023-31-76 | 38.0 | 42 |  | GL-2023-39-11 | 58.0 | 49 | | 16 |  | GL-2023-31-66 | 35.0 | 50 |  | GL-2023-39-28 | 58.0 | 41 | | 17 |  | GL-2023-31-91 | 35.0 | 41 |  | GL-2023-39-106 | 57.0 | 124 | | 18 |  | GL-2023-31-67 | 32.0 | 30 |  | GL-2023-39-90 | 54.0 | 56 | | 19 |  | GL-2023-31-48 | 30.0 | 78 |  | GL-2023-39-95 | 45.0 | 42 | | 20 |  | GL-2023-31-122 | 29.0 | NS |  | GL-2023-39-69 | 43.0 | 70 | | 21 |  | GL-2023-31-53 | 28.0 | 26 |  | GL-2023-39-70 | 41.0 | 94 | | 22 |  | GL-2023-31-19 | 26.0 | 35 |  | GL-2023-39-112 | 40.0 | 16 | | 23 |  | GL-2023-31-99 | 26.0 | NS |  | GL-2023-39-144 | 40.0 | 2 | | 24 |  | GL-2023-31-138 | 21.0 | 63 |  | GL-2023-39-26 | 34.0 | 56 | | 25 |  | GL-2023-31-125 | 19.0 | NS |  | GL-2023-39-46 | 33.0 | 22 | | 26 |  | GL-2023-31-145 | 17.0 | 31 |  | GL-2023-39-102 | 30.0 | 45 | | 27 |  | GL-2023-31-114 | 15.0 | NS |  | GL-2023-39-107 | 29.0 | 57 | | 28 |  | GL-2023-31-126 | 15.0 | NS |  | GL-2023-39-130 | 26.0 | 85 | | 29 |  | GL-2023-31-93 | 15.0 | NS |  | GL-2023-39-41 | 15.0 | 14 | | 30 |  | GL-2023-31-108 | 14.0 | 63 |  | GL-2023-39-43 | 14.0 | 18 | | 31 |  | GL-2023-31-148 | 13.0 | 60 |  | GL-2023-39-47 | 13.0 | 11 | | 32 |  | GL-2023-31-109 | 12.0 | NS |  | GL-2023-39-14 | 12.0 | 19 | | 33 |  | GL-2023-31-72 | 12.0 | NS |  | GL-2023-39-18 | 12.0 | 33 | | 34 |  | GL-2023-31-137 | 11.0 | 128 |  | GL-2023-39-20 | 5.0 | 19 | | 35 |  | GL-2023-31-84 | 11.0 | NS |  | GL-2023-39-74 | 4.0 | NS | | 36 |  | GL-2023-31-110 | 10.0 | NS |  | GL-2023-39-82 | 3.0 | NS | | 37 |  | GL-2023-31-127 | 7.0 | 0 |  | GL-2023-39-80 | 0.0 | 74 | | 38 |  | GL-2023-31-62 | 1.0 | NS |  | GL-2023-39-113 | 0.0 | NS | | 39 |  | GL-2023-31-136 | 0.0 | 13 |  | GL-2023-39-12 | 0.0 | NS | | 40 |  | GL-2023-31-128 | 0.0 | NS |  | GL-2023-39-121 | 0.0 | NS | | 41 |  | GL-2023-31-15 | 0.0 | NS |  | GL-2023-39-45 | 0.0 | NS | | 42 |  | GL-2023-31-21 | 0.0 | NS |  | GL-2023-39-56 | 0.0 | NS | | 43 |  |  |  |  |  | GL-2023-39-9 | 0.0 | NS | | 44 |  |  |  |  |  | GL-2023-39-94 | 0.0 | NS | |