North Aliomanu Beach Green Sea Turtle Nesting Monitoring

2026 Season Final Report: Individual Identification and Accompaniment (Basking) Correlation

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Data final — 2026 season complete, last nest recorded August 1, 2026

1. Executive Summary

This report summarizes the complete 2026-season sea turtle nesting monitoring at North Aliomanu Beach, Kauaʻi. Individual nesting females are identified and tracked across the season using a rule-based nest-interval matching methodology (Section 4), which has to date distinguished 29 individual turtles across 124 recorded nesting events, with 121 nests (98%) successfully assigned to an individual's sequence. As detailed in Section 9, these are the best current estimates under a validated, documented methodology — not confirmed counts. As discussed in Section 8, this program no longer recommends a post-season grid survey as a path to confirming them at a beach this dense; the closest available check remains the Puaena Point validation analog (Section 9).

A second strand of this season's monitoring correlates opportunistic Basking, Explore, and physical excavation ("Large Hole") observations against these individual nesting records (Section 5). Of 21 in-season Basking observations, 15 (71%) coincided with a nest recorded that same night at this beach — a rate above this beach's baseline nesting-activity frequency of 53% of days. Ten of the 29 identified turtles (34%) had a Basking observation recorded on two or more of their separate nesting nights.

Section 6 discusses this recurring pattern as a possible indicator that a subset of nesting turtles are consistently accompanied by a second turtle across multiple nesting events in the same season, and lays out the alternative explanations and additional data that would be needed to confirm or rule out that interpretation. As detailed in Section 2, no physical or genetic sex determination has been performed on any turtle in this program; all sex references in this report (nesting turtles as female, accompanying/basking turtles as presumed male) are behavioral inferences, not confirmed identifications.

Section 3 places this season's numbers in regional context: North Aliomanu's 29 individually identified turtles this season alone already surpass the 22 this beach was credited with in a 2024 two-island correlation study that estimated 79–83 total nesting turtles across Oʻahu and Kauaʻi combined — itself already close to a commonly cited estimate of ~100 turtles nesting per year outside the Lalo (French Frigate Shoals) rookery. This program does not attempt to resolve what that increase means at a population level; it is flagged here for NOAA's assessment.

Section 8 uses this season's density findings to distinguish high-density from lower-density beaches using objective, replicable metrics, sets out this program's own excavation-timing protocol for lower-density beaches, and — revising this program's earlier position — explains why this program will not pursue routine excavation at high-density beaches, deferring instead to controlled-condition studies elsewhere for that biological data.

Section 9 uses Puaena Point — a leeward beach with naturally spaced nests well suited to excavation, unlike windward, high-density North Aliomanu — as this report's validation reference, since its 2024 excavation data was the most reliable that year; North Aliomanu's own 2024 excavation data, by contrast, is shown not to be trustworthy ground truth, for reasons tied to excavation delay and beach conditions rather than the identification methodology. The specific driver of Puaena Point's accuracy ceiling is identified as a high false-crawl rate whose dates overlap real nests, not density on its own; a beach without that specific problem, like North Aliomanu is believed to be, should perform substantially better, though this remains an inference

from the identified mechanism rather than a second ground-truth check. This section also extends the same universal ruleset across all 34 beaches in the 2024 season, and contrasts this approach against a common shorthand — total nests divided by an assumed average of 4 per turtle — which at Puaena Point 2024 would suggest 15.5 turtles against an actual, individually verified count of 8, nearly double the real figure.

2. Background

Data sources: 2026-season North Aliomanu data referenced throughout this report is this program's own field record. The 2024 comparison and validation data used in Sections 3 and 9 (Puaena Point, Secret Beach, Kee Beach, and the full 34-beach 2024 season) was provided via the USFWS nest-monitoring database; original 2024 field data collection was conducted by Malama Na Honu volunteers. Background research literature on nesting density conditions at Lalo (French Frigate Shoals), informing the discussion of high-density beaches in Section 8, was provided by Dr. George Balazs (NOAA Pacific Islands Fisheries Science Center, retired).

Historical and methodological literature on rule-based nest-interval matching, tagging-based population estimation, and clutch-frequency bias — cited in Sections 4 and 9 and listed in full in Section 12 — was also provided by Dr. Balazs: Alvarado and Murphy (1999), Wetherall, Balazs, and Yong (1998), Santos et al. (2023), Esteban, Mortimer, and Hays (2017), and Casale et al. (2022).

North Aliomanu Beach was monitored on a daily basis this season, with concurrent Basking and Explore observation data, making it the focus of this report. Patrol data records date, a field nest number (FWL), patrol frequency (days since the prior visit), and free-text location comments for each nesting event; no tagging or excavation/egg data is used in the identification methodology below.

Sex determination note: no physical, genetic, or laparoscopic sex determination has been performed on any turtle in this program at any point, this season or in prior seasons. Sex references anywhere in this report are behavioral inferences only — an egg-laying turtle is treated as female by definition of the behavior itself, and a non-nesting turtle observed basking on the beach is presumed male by convention, consistent with the terminology used in the beach's 2024 season report. No basking turtle's sex has been directly confirmed, and the 2024 report itself flags this same uncertainty for basking observations. This convention is used throughout for readability but should not be read as a confirmed identification.

Basking timing note: on this beach, basking has not been observed during daylight hours outside the nesting season. Every Basking observation logged this season occurred at night, on a date coinciding with active nest-laying at the beach. This nighttime, in-season-only pattern is part of the basis for treating Basking as behaviorally linked to nesting activity, independent of the same-night correlation results reported in Section 5.

Nest density: GPS coordinates recorded for individual nests this season (Section 5) also make it possible to describe the beach's physical nest density directly, rather than only its nesting count. The distribution is highly uneven — concentrated in a small number of hotspots rather than spread evenly along the shoreline:

Metric (GPS-tagged nests, 2026 season)	Value
Nests with GPS coordinates	124 of 124 (1 missing, FWL 49A)
Shoreline span	~1,020 ft
Overall density	~12 nests per 100 ft (season average)
Median distance to nearest other nest (any night)	3.7 ft
Nests within 1 ft of their nearest neighbor	20 of 124 (16%)

Densest 100 ft stretch of shoreline	52 nests (42% of the season in under a third of the surveyed span)

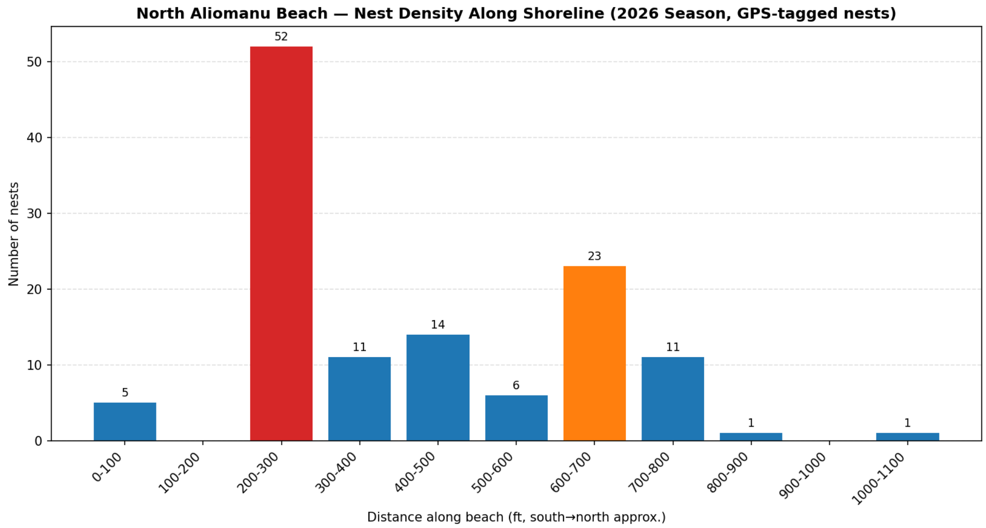

Figure 1. Nest count by 100 ft segment along the North Aliomanu shoreline, 2026 season. Two hotspot segments (200–300 ft and 600–700 ft) account for 75 of the season's 124 GPS-tagged nests; several other segments hold single digits or none.

This distribution is consistent with, and now quantifies, an observation from this beach's 2024 season report: repeated instances of turtles nesting extremely near or directly on top of existing nests. It is directly relevant to the excavation-timing approach in Section 8.

This program has one directly documented case of this happening: on July 11, 2023, a new nest was dug close enough to nests laid that May that its digging ejected eggs from the earlier nest's chamber up onto the surface. Normally, hatching occurs roughly 3 feet underground, and the shells stay in the chamber below as hatchlings dig their own way up to the surface after hatching; here, the eggs themselves were displaced onto the surface by the new nest's excavation, before hatching. Two eggshells were found on the surface at the disturbed site, and two hatchling tracks to the sea were also found nearby — indicating those eggs went on to hatch on the surface, an abnormal and precarious condition, and the hatchlings still made it to the ocean despite it. This is a single documented case, not a systematic study, and this program is not positioned to say how often it occurs beyond this one instance. The extensive on-site studies already underway at Lalo (French Frigate Shoals) — where nest density and re-use of nesting sites have been documented over a much longer record — would be far better positioned to address this question rigorously than this program's single confirmed case.

Figure 5. Eggshell from an egg ejected onto the surface by a new nest dug too close to an earlier May 2023 nest, North Aliomanu, July 11, 2023. Rather than hatching underground as normal, this egg hatched on the surface; two hatchling tracks to the sea nearby indicate the hatchling still reached the ocean despite the abnormal, precarious condition.

3. Historical Context and Regional Population Significance

A 2024 correlation study covering Kauaʻi and Oʻahu beaches, using the same nest-interval correlation logic this program has since formalized (Strict Rules V19/V20), estimated the following:

Island	Estimated Nesting Turtles (2024)	Notes
Oʻahu	31–35	12 beaches surveyed; Puʻaena Point largest (11, possibly 15)
Kauaʻi	48	13 beaches surveyed; North Aliomanu largest (22, "great correlation")
Combined	**79–83**	Compared against a commonly cited estimate of ~100 nesting turtles/year outside the Lalo (French Frigate Shoals) rookery

That combined estimate of 79–83 nesting turtles was compared at the time against a commonly cited figure of approximately 100 nesting turtles per year outside the Lalo (French Frigate Shoals) rookery — itself derived from an estimated population of roughly 4,000 nesting females on a modal 4-year remigration cycle, with about 90% concentrated at Lalo. The 2024 study's own assessment was that 79–83 was "a little bigger than expected, but not significantly."

North Aliomanu Beach's own nest count has swung sharply since then, and 2026 is on pace to be the largest season on record by a wide margin:

Season	North Aliomanu Nest Count
2023	13
2024	85
2025	19

2026 (final)	**124**

This is not a steady trend. 2023 to 2024 was already more than a 6-fold jump; 2025 fell back to near-2023 levels; 2026 came in well above 2024's spike (85) at 124 nests, and roughly 6.5 times 2025's count (19). Section 4 below describes how the 2026 individual count is derived, but the number that matters for the regional context above is the season's turtle count itself, not just nests: this program has independently identified 29 individual turtles at North Aliomanu alone for the complete 2026 season — already surpassing the 22 turtles the 2024 study attributed to this same beach for its entire season, and a meaningful fraction of that year's full 79–83-turtle two-island estimate, from one beach.

Taken at face value, if North Aliomanu's final 2026 individual count (29, per Section 4) is added to the rest of the 2024 two-island survey unchanged, the regional total would already sit above the ~100-turtle benchmark from this beach's growth alone, before accounting for any 2026 change at the other 24 surveyed beaches. Several explanations are possible and are not distinguishable from this program's data alone:

- Genuine population growth or redistribution — e.g., a documented shift of nesting effort away from Lalo, which has experienced repeated storm and sea-level-rise habitat loss in recent years, toward main Hawaiian Island beaches.
- A real but non-repeating high-nesting year — green sea turtles are well known for high year-to-year nesting variance tied to individual remigration cycles and regional food availability; 2024's spike and 2025's crash at this same beach are themselves evidence of that variance, and 2026 could be another such swing rather than a sustained new baseline.
- The ~100-turtle outside-Lalo benchmark itself may be due for revisiting — it was described to this program as an approximate figure, not a directly measured count, when the 2024 study was conducted.

One explanation that does not apply here: North Aliomanu has been monitored daily during nesting season in all four years shown above (2023–2026), so a change in monitoring effort or coverage is not a plausible driver of the swings in this table — the count in each of those years reflects a consistent level of patrol effort, not an artifact of watching more closely in some years than others.

This program is not positioned to distinguish between the remaining explanations; that determination is deferred to NOAA and partner agencies with population-level survey data across the full nesting range. What this program can offer is the individual-level count from one closely monitored beach, tracked with a consistent, auditable methodology across three consecutive seasons, showing that beach alone approaching a scale comparable to the entire prior two-island estimate.

4. Methodology — Individual Identification

Individual turtles are not tagged in this program; identity is inferred from nest-interval biology. Green sea turtles renest at a modal interval of 14 days, with an accepted biological range of 11–18 days between successive nests of the same female. Two nesting events are treated as candidates for the same individual only if their dates fall within this window (adjusted for patrol frequency where a nest's exact date is uncertain).

Patrol frequency ("Freq") records how many days have elapsed since the beach was last checked, and it determines whether a recorded nest date is treated as exact or as the upper bound of a range. When a beach is patrolled daily (Freq = 1), the recorded date is the nest date itself. When a patrol gap is longer (Freq > 1), the true nest date could fall anywhere in the days since the prior visit, so the recorded date is instead treated as the latest possible date, and the earliest possible date is calculated by subtracting the gap length. A candidate pairing between two nests is accepted if any date within each nest's possible range can combine to produce a valid 11–18-day interval, and rejected only if no combination of possible dates can do so. This keeps daily-patrolled beaches at full precision while still allowing beaches with sparser patrol schedules to be analyzed without discarding their data or forcing a false level of precision onto an uncertain date.

Rather than pairing nests in the order they are encountered, the full season's nest-date graph for the beach is solved as a global minimum-cost matching: every valid nest-to-nest link is considered simultaneously, and the solution that (a) forms the most total valid links and (b) keeps the resulting gaps closest to the 14-day biological norm is selected. This avoids a known failure mode of simpler sequential matching, in which an early, arbitrary pairing decision can fragment what is actually one turtle's consistent sequence into several shorter, weaker ones.

This date-interval matching approach follows an established alternative to physical tagging in sea turtle nesting research, formalized for green turtles in Alvarado and Murphy (1999) and applied with an explicit rule structure to hawksbill turtles by Santos et al. (2023), who classified subsequent emergences within a shorter, regionally-calibrated window as false crawls and the final emergence in a burst as the true nest. This program's own 11–18 day window and burst-handling logic (Rule 1, companion rules document) follow the same general approach, calibrated to green turtle biology and this program's own Puaena Point ground-truth data (Section 9) rather than to the hawksbill-specific parameters in Santos et al. (2023).

An additional constraint (adopted 2026-08-01, this season) further requires that once a sequence reaches 4 confirmed nests, any further extension must fall within a tighter 13–15-day gap. A 5th-or-later nest reachable only via a looser 11–12 or 16–18-day gap is treated as a new individual's first nest rather than a continuation, since an established 4-nest layer has already demonstrated a consistent rhythm that a loose deviation is more likely to break from than continue. Applying this constraint reduced this season's single longest sequence from 7 to 6 nests and improved internal gap consistency across five other sequences.

Each individual is assigned a sequential letter (A, B, C…) ordered by the date of her first nest of the season. This letter is a within-season bookkeeping label only — it carries no information linking her to prior seasons.

Season summary, North Aliomanu Beach (final, 2026 season)

Metric	**Final Value**
Individual turtles identified	29
Total nests recorded	124
Nests assigned to a turtle sequence	121 (98%)
Nests unassigned	3
Longest confirmed nesting sequence	6 nests

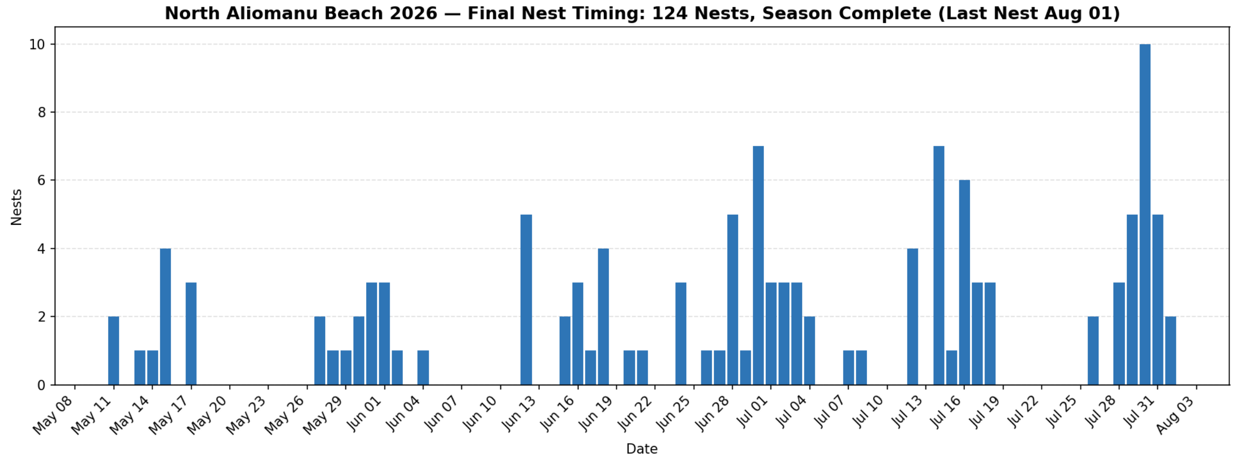

Figure: North Aliomanu actual nests recorded by date, final 2026 season (124 nests, May 11 – August 1).

The three unassigned nests above (FWL 104, 105, and 115; recorded July 30–31) were not solo nests in the strict sense of having no candidate partner in range. All three fell within a valid gap of the July 12–18 nesting burst, but every one of those candidate nests had already been claimed as the terminal nest of an established 6-nest chain by the time the global optimization settled — so the methodology correctly declined to break a longer, better-supported sequence to accommodate them (Rule 3a chain priority; reason code "Pair absorbed by longer sequence"). This independently matches field notes flagging observer uncertainty on those same two high-count nights (10 nests recorded July 30, 5 nests July 31), and is offered as a concrete illustration of how this methodology handles its busiest nights rather than as a data-quality concern.

The season did not taper off quietly — it closed on its single heaviest stretch. The final three recorded days (July 30, 31, and August 1) produced 12, 6, and 2 combined nesting and observation events respectively, including the season's busiest single night (10 nests, July 30). At this density, nests were physically close enough that some partially overlapped or covered one another in the field, consistent with the concentration of unassigned nests (FWL 104, 105, 115) landing in exactly this window. No new nests were recorded in the two weeks following August 1, which this report treats as confirmation that the season concluded there rather than a gap in coverage.

5. Methodology and Results — Basking Correlation

Independent of nest identification, field observers this season logged three additional event types at North Aliomanu: Basking (turtle tracks observed on the beach without an accompanying nest, presumed male by the behavioral convention noted in Section 2, believed to indicate a turtle accompanying a nesting female that night), Explore (a turtle that comes ashore and investigates the nesting area but returns to sea without laying), and Large Hole (a physical excavation of a size distinct from a normal nest or body pit, of unconfirmed origin).

Field observations this season distinguish two patterns within the Explore category, occurring at roughly similar rates, with the second slightly more frequent than the first. The first is straightforward exploration: a turtle comes ashore into an area away from existing nests, sometimes moving off the sand itself into adjacent vegetation, and returns to the ocean without laying. The second — also observed in prior seasons — involves a turtle tracking directly through four or five existing nest pits before returning to the water. This program has no explanation for the second pattern and notes it here as an observation rather than an interpretation.

One Large Hole from this season is still present at the time of this report and is described here as a specific example rather than a general finding. Located in the scrub just off the sand, it measures approximately 4.5 ft deep across a 14 ft by 13 ft area. On the first day it was observed, no turtle tracks were present, though excavated sand had been thrown out onto the beach; on the second day, a single turtle track led to the pit area. This program has no explanation for what produced it.

Basking observations were correlated against the individual nesting sequences from Section 4 by same-calendar-date match at this beach. Explore and Large Hole observations were logged but not correlated to a specific nest or individual in this report: an Explore event has no eggs laid that night by definition, so a same-night match is not meaningful, and no validated method yet links a specific Explore or Large Hole observation to a specific later nesting event or individual. This is flagged in Section 7 as an area for further method development, not a finding.

Where a Basking event coincided with more than one same-night nest, this report applies the correlation ruleset's Version 6 candidate-narrowing rules (companion document, Rules B3-i and B3-ii) rather than guessing among them. Of the 21 in-season Basking events, 15 had more than one same-night nest candidate. Location-label narrowing (Rule B3-i) resolved almost none of these, since this beach reuses a small set of generic location labels ("1st reef," "2nd reef," and similar) that rarely distinguish between same-night nests. GPS-based narrowing (Rule B3-ii, new this version, using GaiaGPS waypoint data) did better on one specific case: the June 18 Basking event narrowed with high confidence to FWL 38 (Turtle O), at 55 ft, against a next-closest candidate at 210 ft — a clear standout by this rule's 2× threshold. One further event (May 31) had a closest candidate at 969 ft, which exceeds this beach's observed same-night nest-to-nest spacing (up to ~707 ft) and is flagged as a probable GPS data-quality issue rather than used. The remaining 13 multi-candidate events stay ambiguous even with GPS — at this beach's nest density, same-night nests are frequently close enough together that GPS positioning noise cannot reliably tell them apart. These 13 are retained in the record ranked closest-candidate-first rather than as an unordered list, per Rule B3-ii.

Basking correlation results

Metric	Value
Basking observations logged	25 (4 pre-season / early-test, 21 in-season)
In-season Basking events matched to a same-night nest	15 of 21 (71%)
Baseline nesting-activity rate at this beach	53% of days (44 of 83) had ≥1 nest
Distinct turtles with ≥1 same-night Basking match	19 of 29 (66%)
Turtles with Basking matches on ≥2 separate nesting nights	10 of 29 (34%)

The 71% same-night match rate for Basking observations, against a 53% baseline rate of any nesting activity on a given night, is consistent with the working hypothesis that Basking represents a second turtle, presumed male, accompanying a nesting female on her nesting night. It is not, on its own, statistical proof of that relationship, and does not confirm the accompanying turtle's sex — see Section 7.

6. Discussion — Basking Recurrence and Possible Group Travel

Ten of the 29 individually identified turtles at North Aliomanu Beach this season had a Basking observation recorded on two or more of their own separate nesting nights — not simply two Basking events on the same date, but two or more distinct nesting occasions, weeks apart, each independently coinciding with a Basking observation. The table below lists these ten individuals.

Turtle	Nesting Nights	Nights with Basking Match	% Matched
N	5	4	80%
O	4	3	75%
L	5	3	60%
M	5	3	60%
I	6	3	50%
J	6	3	50%
K	6	3	50%
G	6	3	50%
V	3	2	67%
H	6	2	33%

One individual stands out numerically: Turtle N, with Basking observed on 4 of her 5 nesting nights (80%). Turtle O shows Basking on 3 of 4 nights (75%). Ten individuals in total show a recurring pattern of 2 or more separate nesting nights with a Basking match, detailed below.

One interpretation consistent with this pattern is that a subset of nesting females at this beach may be consistently accompanied by the same or a small set of other turtles, presumed male, across multiple nesting events within a season — i.e., that some pairings or small groups persist across a female's nesting season rather than being a single-night, one-off association. This would be consistent with informal field reports of accompanying turtles remaining in the near-shore waters of a nesting beach for extended periods during the season, positioning them to encounter the same females repeatedly. If accurate, this would have implications for how reproductive investment and encounter rates are modeled for this population.

Similar basking activity involving multiple specific turtles was also observed and documented in 2024, consistent with this season's pattern. The 2024 report explicitly declined to assign a confirmed sex to the accompanying baskers in that case, noting only that literature did not clearly support the behavior. The 2026 season's quantitative Basking-correlation data (Section 5) is consistent with that same pattern recurring at the population level, rather than being an isolated case, but neither year's data confirms it.

This interpretation should be treated as a hypothesis generated by this season's data, not a confirmed finding, for four reasons:

- No sex determination performed. As noted in Section 2, no physical or genetic sex determination has been performed on any turtle in this program. "Male" and "presumed male" in this discussion refer to the behavioral convention of a non-nesting turtle observed basking, not a confirmed identification.
- No individual identification of accompanying turtles. Basking events are dated observations of a second turtle present, not identifications of a specific individual. A recurring match to the same nesting female across her season is consistent with, but does not by itself demonstrate, that it is the same accompanying individual each time — it is equally consistent with different turtles being drawn to the same reliably-productive stretch of beach on different nights.
- Base-rate sensitivity. With a beach-wide baseline nesting-activity rate of 53% of nights, a moderate same-night match rate is expected by chance alone even absent any real relationship; the 71% rate reported here is a meaningful signal above that baseline but the margin is not large enough, on the current sample of 21 Basking events, to rule out chance co-occurrence as a partial explanation.

- No shared identifier between Basking logs and nest records that fully resolves multi-nest nights. Free-text location labels (Section 7) narrowed only 2 of 21 events, none fully. GPS coordinates (added 2026-08-01, from field waypoint exports) did better — they allow every ambiguous night to be ranked by actual distance rather than left as an unordered list — but only 1 of 14 multi-candidate Basking events reached high-confidence single-nest resolution. This beach's nest density is high enough that same-night nests are frequently within ordinary GPS-noise distance of each other, so even accurate coordinates do not fully resolve busy nights.

Recommended next steps to test this hypothesis are given in Section 7.

7. Limitations and Recommendations for Future Data Collection

- GPS-based narrowing tested (2026-08-01): field GPS waypoints (date, time, and coordinates for each Basking, Explore, Large Hole, and Nest event) were matched to the existing records and used to narrow same-night Basking matches by real distance instead of a text label. Result: a genuine but modest improvement — ambiguous nights can now be ranked closest-first rather than left unordered, and 1 of 14 previously-ambiguous events resolved to high confidence, but the beach's nest density is high enough that most same-night nests remain within ordinary GPS-noise distance of each other. Continuing to log GPS for every event is still worthwhile (it is strictly more informative than a text label), but should not be expected to fully resolve busy-night ambiguity on this beach without a higher-precision positioning method.
- Where feasible, photograph-ID or flipper-tag basking turtles, even opportunistically, to test directly whether repeat Basking observations for a given female involve the same accompanying individual — and, ideally, to obtain an actual sex determination rather than relying on the behavioral convention used in this report.
- Continue logging Explore and Large Hole events through the remainder of the season; a larger sample and/or a defined linking method (e.g., a consistent location comment tying an Explore visit to a specific later nest) would allow those observation types to be brought into the correlation analysis in a future report.
- Revisit this report's individual counts and sequences after the season concludes in late August, when the full-season dataset is final and no further nests are expected.

8. Nest Density and This Program's Approach to Excavation Timing

Scope of this discussion: this section and Section 9 raise specific concerns about excavation — nest disturbance risk at high-density beaches, and accuracy for estimating total turtle counts. Neither is a general critique of excavation as a research method or a claim that it should be curtailed broadly. Excavation produces data (hatch success, clutch size, incubation duration, embryo development, and other biological detail) that no method in this report can substitute for, and it remains valuable and appropriate wherever it can be conducted reliably, including at beaches like Puaena Point where nest spacing and site conditions support it well (Section 9). Nothing here is directed at emergency excavation — relocating or otherwise protecting a still-incubating nest, before the normal hatch period is complete, when it is actively endangered and would likely be destroyed and its eggs killed if left in place. That is permitted under the Endangered Species Act and is an important, distinct tool for saving a nest that would not otherwise survive, unrelated to the routine, scheduled excavation for post-hatch data collection this section and Section 9 discuss. The observations here are about the timing and conditions of that routine excavation, not about emergency intervention, and are about matching the method to the beach and the question — excavation for biological detail where conditions support it, non-invasive methods for turtle-count accuracy and for beaches where excavation carries disturbance risk — not a case against excavation itself.

This section also draws on background research literature covering nesting density conditions at Lalo (French Frigate Shoals), provided by Dr. George Balazs (Section 2), as context for a beach-density concern that is not unique to North Aliomanu.

This season's nest-density mapping (Section 2) shows North Aliomanu qualifies as a high-density nesting beach by any reasonable measure: 124 nests across roughly 1,020 ft of shoreline, with one 100 ft stretch alone holding 42% of the season's nests and a median distance of only 3.7 ft between a nest and its nearest neighbor. This program has not observed any excavation at North Aliomanu this season, and this section is offered as a forward-looking note rather than a report of any specific incident.

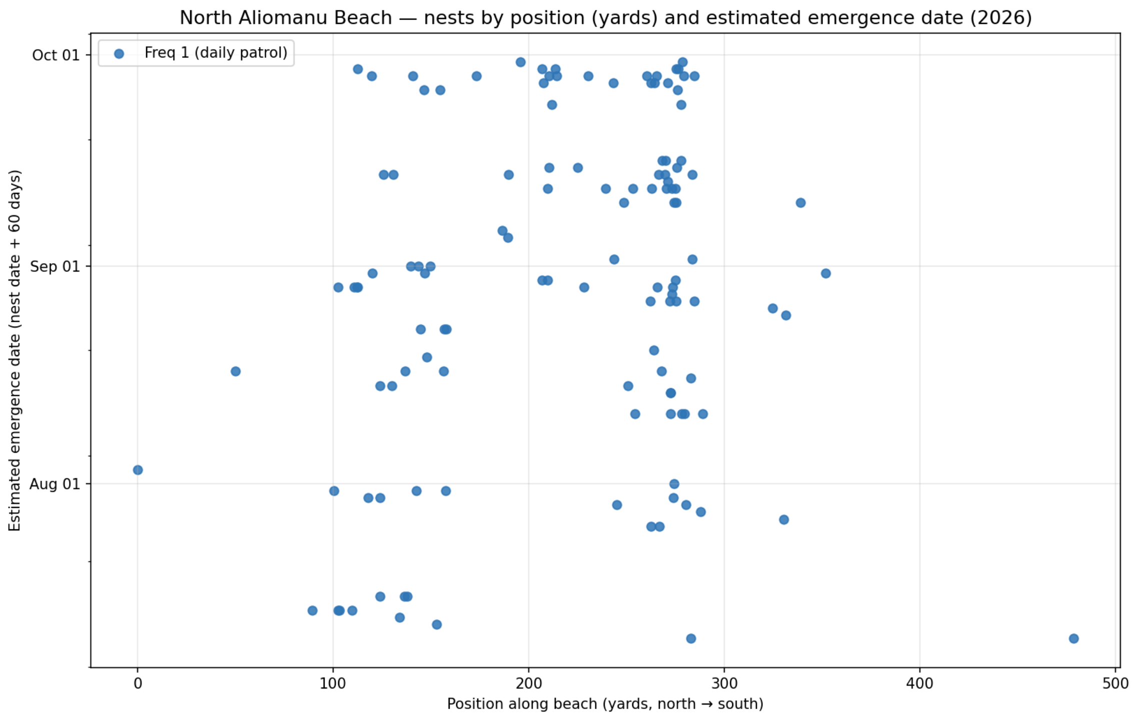

Figure: North Aliomanu nests by position along the beach (GPS-derived, yards) and estimated emergence date (nest date + 60 days, this dataset's "Norm Hatch" convention). 123 of 124 nests had usable GPS.

This program tracks the 60-day norm-hatch estimate for every nest as a matter of course (the "Norm Hatch" column referenced throughout this report and used directly in the excavation-timing rule below); the figure above makes that timeline explicit by plotting it against each nest's position along the beach. Estimated emergences are spread across roughly ten weeks (early August through early October) and are concentrated in the same 200–290 yard stretch identified in Section 2 as the season's densest, meaning the disturbance-risk window this section describes is not a brief one — it persists for most of the post-nesting season, in the same tightly packed area.

At this density, locating and opening any one nest for excavation carries a meaningful risk of disturbing a neighboring nest simply because of how tightly nests are packed together, independent of timing. This is not a hypothetical risk: Section 9 shows density forcing excavation to wait for nearby, later-laid nests to finish at North Aliomanu in 2024, with a median excavation delay of 102 days as a direct, measured result. Nests per 100 ft of shoreline or median nearest-neighbor spacing (both demonstrated in Section 2) are objective, replicable metrics that distinguish a beach like this one from lower-density sites, and this program uses that distinction to set its own excavation approach below, separately for each density tier. This program does not have visibility into NOAA's broader excavation standards or how conditions compare across other beaches, so this distinction is offered as a data point from one beach's season, not a call for NOAA to adopt a formal definition.

For lower-density beaches, this program applies a concrete excavation-timing rule of its own, rather than relying on a general standard alone: excavate no earlier than 70 days after the nest date, or 7 days after the first observed emergence at that nest, whichever is later. The 70-day floor covers the outer end of the green sea turtle incubation range plus a margin before any hatching activity is expected, guarding against opening a nest before it has begun to hatch. The 7-day trigger reflects NOAA's own standard that a nest's hatchling emergence, from first emergence to natural completion, spans about a week rather than a single night — a short quiet period alone is not a reliable signal that emergence is finished, so a nest already past 70 days when emergence is first observed should still be given a further 7 quiet days before it is opened. Beaches that qualify for excavation under this rule remain valuable: the resulting hatch-count and clutch data is exactly what this program needs to refine and validate its identification methodology going forward, in the same way Puaena Point's 2024 data did for this report (Section 9).

For high-density beaches specifically, this program is revising its earlier position: timing adjustments alone are not sufficient given how close together nests are, but on further consideration, a post-season grid survey does not solve the underlying problem either, and this program no longer recommends it as a substitute. The core difficulty at a beach as dense as North Aliomanu (median 3.7 ft between nearest-neighbor nests, with a documented 102-day excavation delay already forced by proximity in 2024; Section 9) is not only when to excavate but whether the resulting eggs, shells, and hatchling remains can be attributed to a specific nest at all. A grid search conducted after the season, across a shoreline stretch where nest chambers may sit within inches of one another, would very likely recover mixed material from more than one clutch in the same excavated area, with no reliable way to sort it back to individual, GPS-recorded nesting events. Genetic (DNA) testing of recovered eggs could establish that material from more than one female is present, but it does not solve that attribution problem: typical patrol-GPS error is on the same order as, or larger than, this beach's 3.7 ft median nest spacing, so a genetic match cannot be tied with confidence to one specific recorded nest rather than its immediate neighbor. Separately, this program has direct evidence that nest material can persist at a site across more than one season (Section 9), so any sample recovered post-season cannot be assumed to belong to the current year's nest without an additional degradation- or age-dating step performed on each sample. Combining genetic testing with age-dating across a beach with this many nests would require sustained work from specialized personnel at a scale this program does not consider realistic given current and tightening budget conditions, and even a fully resourced version of that effort would still leave meaningful attribution uncertainty at the individual-nest level. Given that this level of verification is not achievable here without a disproportionate and likely still-inconclusive effort, this program will not pursue excavation at high-density beaches like this one, whether during the season or after it, for routine hatch-success or clutch data collection. Biological ground-truth data of that kind is expected to keep coming from studies conducted under more controlled conditions, such as those at Lalo (French Frigate Shoals) referenced in Section 2, where nest spacing and site conditions permit reliable individual-nest attribution without disturbing nests at a beach like this one. This applies to routine, scheduled excavation only. It does not apply to emergency excavation to protect an actively endangered, still-incubating nest that would otherwise likely be destroyed — that intervention remains appropriate regardless of density, and takes priority over any statistical or methodological consideration raised in this report.

9. Non-Invasive Turtle Counting: Why This Matters Most on Windward, High-Density Beaches

Puaena Point (Oʻahu) is a leeward beach with naturally spaced-out nesting — conditions well suited to excavation, since digging up any one nest there carries little risk of disturbing a neighbor. North Aliomanu is windward and, as Section 2 shows, extremely dense in places. That combination is exactly what Section 8 argues makes excavation unreliable and potentially harmful at this beach: windward conditions are understood to make excavation-based results inconsistent, and this beach's nest spacing compounds that further. Puaena Point is close to the best-case beach for excavation; North Aliomanu is close to the worst case.

This asymmetry is the reason Puaena Point is used here for validation rather than as a general model: it is the one beach in this comparison where excavation-based ground truth can actually be trusted, which makes it possible to check this program's non-invasive, date-only identification methodology against a known answer. The result of that check is the case for why this methodology matters most on beaches like North Aliomanu, not despite lacking excavation data, but because excavation itself is not a reliable source of truth there to begin with.

Puaena Point's 2024 data includes excavation-confirmed results — eggs found or not — for each of that season's 62 recorded events (34 confirmed real nests, 27 confirmed false crawls, 1 not excavated). Run with no knowledge of which events were false crawls — the same date-only approach used for North Aliomanu all season — this program's methodology assigns 95% of events to a turtle sequence, a rate essentially indistinguishable from North Aliomanu's own 98% (Section 4). Checked against the excavation-confirmed ground truth, only 13–41% of those groupings are actually correct depending on configuration — all of them still well short of what excavation-based correction achieves.

Two separate, genuine improvements came out of testing this against ground truth, one usable without excavation data and one that requires it:

- Without excavation data: narrowing Rule 1's valid-gap window from 11–18 days to 11–16 days (excluding only the loose 17–18 day end — the loose 11–12 day end made no measurable difference) roughly doubles precision and recall using date data alone. This is a permanent, egg-free rule refinement, usable in-season and at any beach.
- With excavation data, after the season: excluding excavation-confirmed false crawls before chain-building, rather than leaving them for a date-only algorithm to sort out, raises accuracy to 94% precision and 100% recall — shown in full below.

Configuration	Precision	Recall
No excavation data used (usable in-season, any beach):		
Standard 11–18 day window (date-only)	13.1%	15.7%
Prior greedy method, Puaena-tightened 12–16 window	40.7%	14.5%
Refined 11–16 window (date-only, this analysis)	**32.1%**	**32.5%**
Excavation data used (post-season only):		
Confirmed false crawls excluded before chain-building	**93.9%**	**100%**

Even the best pure date-only configuration found tops out around 30–35% precision. This is a structural ceiling, not a tuning gap: at Puaena Point, false crawls fall within the same nesting rhythm as real nests often enough that no amount of date-only refinement fully separates them. Excavation closes that gap decisively — but only at a beach where excavation is actually reliable to perform.

A third method is worth naming explicitly, because it is a common shorthand: estimating turtle count by dividing total recorded nests by an assumed average of 4 nests per turtle. Applied to Puaena Point 2024, that gives 62 ÷ 4 = 15.5 turtles — nearly double the actual, individually verified count of 8. This is not a rounding error; it is what happens when the two assumptions behind that shorthand both fail at once: not every recorded event is a real nest (27 of the 62 were confirmed false crawls, not turtles at all), and real turtles do not nest a uniform 4 times each (this program's own accepted range is 3–9 nests per season). A single division by a fixed average carries no way to detect either problem. Individual identification — whether the date-only version used in-season or the excavation-corrected version used after — is not a refinement on that shorthand; it answers a different and much more specific question, which nests belong to the same animal, and that is the only way to get a turtle count that is not simply an artifact of how many events happened to be logged.

This finding is consistent with independent literature on the same shortcut. Esteban, Mortimer, and Hays (2017) used satellite tracking to catch nesting events missed by standard foot patrols and found that clutch-frequency estimates based on patrol counts alone were 1.7–1.9 times lower than the satellite-corrected figures, meaning traditional patrol-based population estimates have tended to undercount how many times each female nests — the same root problem demonstrated here, though it can push a resulting population estimate in either direction depending on which assumption fails. Casale et al. (2022) similarly ground-truthed several current abundance-estimation methods against a population with genetically confirmed clutch assignments and found current approaches, including the divide-by-average-clutch-frequency method, produce biased nester abundance estimates. Both studies support this report's conclusion that a fixed-average-division shortcut is not a reliable substitute for individual identification, whether by tagging, genetics, satellite tracking, or the date-interval method used here.

North Aliomanu does not have that option in the same way. Its 98% assignment rate should be read as a same-order-of-magnitude number to Puaena Point's pre-correction figures above, not as a validated accuracy figure — but the fix available at Puaena Point (excavate, then exclude confirmed false crawls) is the fix this program's own Section 8 argues against applying at scale on a beach this dense and this exposed. That is the central case for this toolkit: it is what allows an accurate, defensible turtle count and pattern-level monitoring at exactly the beaches — windward, high-density — where the traditional excavation-based approach is least trustworthy and most likely to cause harm.

The same non-invasive approach also supports detecting a disturbed beach without excavation. A beach's unassigned-nest rate and chain structure should be reasonably stable relative to its own history; a sudden rise in unassigned nests, or an unusual break in what were previously consistent turtle sequences, is a pattern-level signal worth a field look — for human disturbance, a monitoring gap, or an environmental change — well before excavation would ever confirm or rule it out. This is the basis for the mid-season step of the cadence recommended below.

Puaena Point's own 2024 season is a real example of this signal, not a hypothetical one. Once the beach's nesting pattern was established (May 12 – June 29), only 23% of nests were unassigned — a stable, expected baseline. From June 30 onward, that rate more than doubled to 54%, and stayed elevated for the rest of the season:

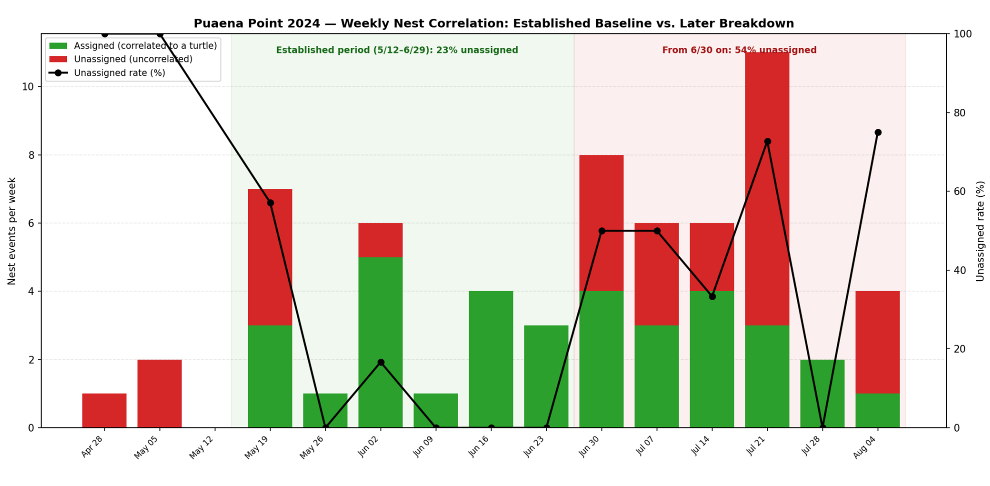

Figure 2. Weekly assigned/unassigned nest counts at Puaena Point, 2024, with the unassigned rate overlaid. The shift from the established baseline (green) to a persistently higher unassigned rate (pink, from June 30 on) is visible without any excavation or ground-truth data — it comes directly from the same date-only correlation used throughout this report.

This shift is independently consistent with this program's field understanding that Puaena Point experienced disturbance during this period. The point is not that this specific shift was detected in real time in 2024 — it is that the same pattern-level signal used here retrospectively is available prospectively, in-season, at any beach under the mid-season step of the cadence below, without needing excavation or after-the-fact knowledge that something happened.

Full 2024 season, all beaches, universal rules

This methodology was then run across the complete 2024 season for every monitored beach in that year's dataset — 34 beach sections, not only Puaena Point — using the same universal ruleset described above, applied identically everywhere with no beach-specific configuration:

Beach	Turtles	Assigned	Unassigned	Total
North Aliomanu Beach	19	78	7	85
Puaena Point	8	34	28	62
Secret Beach	5	12	10	22
Ft Hase	5	20	7	27
Mahaulepu Beach	4	12	1	13
Olonio Street	4	13	1	14
Turtle Bay	4	17	2	19
James Cambell	4	13	1	14
Larsens Beach	3	9	6	15
(25 additional beaches, 0–3 turtles each — full detail in accompanying workbook)				
GRAND TOTAL (34 beaches)	**75**	**260**	**117**	**377**

Running the ruleset at this scale surfaced and fixed two real problems that a single-beach test could not have caught. First, the Wave Capacity constraint (Rule 4a) had a bootstrap flaw: a beach that never happens to form an established 3+ chain can never build the "active chain" baseline the rule depends on, so it defaulted to blocking every candidate outright — Secret Beach's 22 nests initially returned zero turtles for exactly this reason, not because the underlying dates were invalid. Second, once that lockout was fixed, the rule's fixed numerical margin — calibrated at Puaena Point's 62-nest scale — did not generalize down to a small, locally-clustered beach; several rescaled versions were tested against Puaena Point's ground truth and none preserved its validated result while also fixing the small-beach case. Rule 4a is now scale-gated (active only at beaches with ≥40 total nest events that season, currently North Aliomanu and Puaena Point in this dataset) rather than rescaled, and Puaena Point's validated result is confirmed unchanged by this fix (8 turtles, 34/28 split).

Separately, a new rule (3-ii, Missed-Visit Location Linking) was added to recover structure at beaches where patrol frequency is too sparse to sample the 14-day nesting rhythm reliably: when a field comment explicitly cross-references an earlier nest by number across a clean multiple of 14 days, that link is now used, subject to two filters that were added after an unfiltered first version produced false positives — excluding any reference where the observer's own comment indicated the two nearby nests were believed to be different turtles, and excluding numbers reused as a physical landmark across many unrelated dates.

A comparison against an independent 2024 manual correlation study covering 23 beaches across Oʻahu and Kauaʻi — conducted separately from this methodology, by hand — then surfaced a third problem with the same root cause: the 11–16 day density window (Rule 4), like Wave Capacity, had been made unconditional across every beach in V22–V23, but was calibrated only at Puaena Point's scale. Kee Beach returned 0 turtles under that unconditional window because its only candidate pairings are 18-day gaps, which the window excludes — while the manual study independently estimated roughly 3 turtles there. This window is now scale-gated using the same ≥40-event threshold as Rule 4a. The result is a genuine trade-off, not a uniform improvement: total deviation from the manual study's 23 comparable beach counts dropped from 23.5 to 19.5, with several beaches moving closer to the manual estimates and one (Larsens Beach) moving one turtle further away as the wider window let a different, competing pairing win out there. Puaena Point's validated result is unchanged either way.

The manual study and this methodology are otherwise strikingly consistent, despite being produced independently:

Beach	**This methodology (2024)**	**Independent manual correlation (2024)**
East Malaekahana	1	1
Aweoweo Beach	1	1
Tunnels	2	2
Waiakalua Iki Beach	0	0
Moloaʻa Bay	1	1
Mahaulepu Beach	4	4
Shipwreck Beach	2	2
Secret Beach	5	~6
North Aliomanu Beach	19	22
Kee Beach	2	~3
Larsens Beach	3	4
Puaena Point	8	11–15

Eight of the twelve beaches shown match exactly; the rest are within a few turtles. This is not a third accuracy validation — the manual study is itself an experienced-observer estimate, not excavation-confirmed ground truth — but it is a meaningful independent corroboration of both this methodology and the field judgment behind the original study, arrived at by two different methods without either informing the other at the time.

This is offered as a demonstration of generality and of the value of testing at scale, not as a second accuracy validation against ground truth: Puaena Point is used as this report's validation reference because its 2024 excavation data was the most reliable that year (Section 9), not because other beaches lack excavation data. The other 33 beaches' turtle counts are produced by the same rules, at the same demonstrated accuracy ceiling, but without a comparably trustworthy ground truth to check them against.

Methodology confidence: why Puaena Point is the validation reference

All beaches in the 2024 season had excavation data, not only Puaena Point. Puaena Point is used as this report's validation reference because its excavation data was the most reliable that year, not because it was the only beach with any — and North Aliomanu's own 2024 excavation data illustrates directly why that distinction matters.

At North Aliomanu in 2024, 19% of excavated nests had eggs confirmed (16 of 84 excavated; 1 of the season's 85 nests was never excavated). Checked against that small egg-confirmed subset, the beach's otherwise very high raw assignment rate (in the same 90%+ range this report shows for 2026) collapsed to near zero — the opposite of Puaena Point, where a similarly high raw rate corresponds to a real but limited accuracy (Section 4), and where restricting to egg-confirmed nests brings accuracy to over 90% (Rule 8, Section 8's companion rules document). The most likely explanation is not that the identification methodology fails at North Aliomanu: it is the same density mechanism Section 8 raises as a disturbance-risk concern, showing up here as a data-quality one. At a beach this dense, a nest often cannot be safely excavated until nearby, later-laid nests have also finished their own incubation, to avoid disturbing them — so excavation is forced to wait, not by choice but by the physical proximity of neighboring nests. Puaena Point's widely spaced nests carry no such constraint; excavation there could happen as soon as desired. Computed directly from that season's recorded nest and excavation dates, North Aliomanu's excavation delay had a median of 102 days (mean 105, range 67–161 days, n=84), with 67% of excavations occurring more than 90 days after the nest was laid, versus a median of 65 days at Puaena Point (mean 72, range 54–110 days, n=61) — still too early by this report's own 70-day threshold (Section 8), but reflecting a timing choice rather than a density-forced necessity. On a windward, flood-prone beach, repeated wave action and flooding repack the surface sand over a wait that long, most likely erasing the disturbed-sand signal that probing depends on to locate a chamber, rather than destroying the eggs themselves — and ordinary rainfall contributes to the same settling even without flooding, over a delay this long. At a dense beach, this is compounded further during that same wait by the repeated digging of other new nests nearby, which repacks and disturbs the surrounding sand independently of any flooding — the denser the beach, the more this happens, tying this problem to the same density mechanism as the delay itself. So a low egg-find rate under those conditions more likely reflects a failure to locate nests that are still there than nests that were never real, though some genuine degradation of the eggs over so long a delay is also plausible and likely contributes as well. Puaena Point's comparatively pristine, widely spaced, non-flooding conditions meant neither of these locating problems arose there even at its own too-early excavation timing.

The excavation-finding technique itself compounds this problem. A nest chamber is located by probing for disturbed sand — the area where the chamber was originally dug and where hatchlings later broke the surface — which is a subtle physical signal that settles and fades with ordinary rainfall over time even without flooding, and can be erased faster by coastal flooding that repacks and redistributes the surface sand, or by the digging of other new nests nearby, which is more likely the denser the beach. This fading, physical-signal problem is a separate reason — beyond the individual-nest attribution issue discussed in Section 8 — that excavation-based methods, whether standard probing or a systematic post-season search, cannot be relied on to close the ground-truth gap at a beach this dense.

This program has direct, documented confirmation that this failure mode is real, not just plausible. On February 19, 2026, coastal erosion at North Aliomanu exposed an intact egg chamber from a nest laid in June 2024. That nest had been excavated in 2024, found no eggs, and was recorded accordingly — yet the eggs were there the entire time, simply not found by probing at the time of excavation. The exposure itself was brief: the remaining eggs were gone by erosion the next day, and the site was fully re-buried by reverse erosion within a week — a firsthand illustration of exactly how fleeting this kind of physical evidence is once it is exposed, let alone before. This is a single confirmed case, not a basis for recalculating the 19% rate, but it is direct evidence that at least some of North Aliomanu's 2024 "No Eggs Found" results reflect a failure to locate a real nest rather than a real absence of eggs, exactly as the pattern above would predict.

Figure 4. Egg chamber from a June 2024 nest, exposed by coastal erosion at North Aliomanu, February 19, 2026 — recorded as "No Eggs Found" upon 2024 excavation. Shell fragments are visible in the eroded bank. The exposure lasted only days before further erosion and re-burial removed the evidence again.

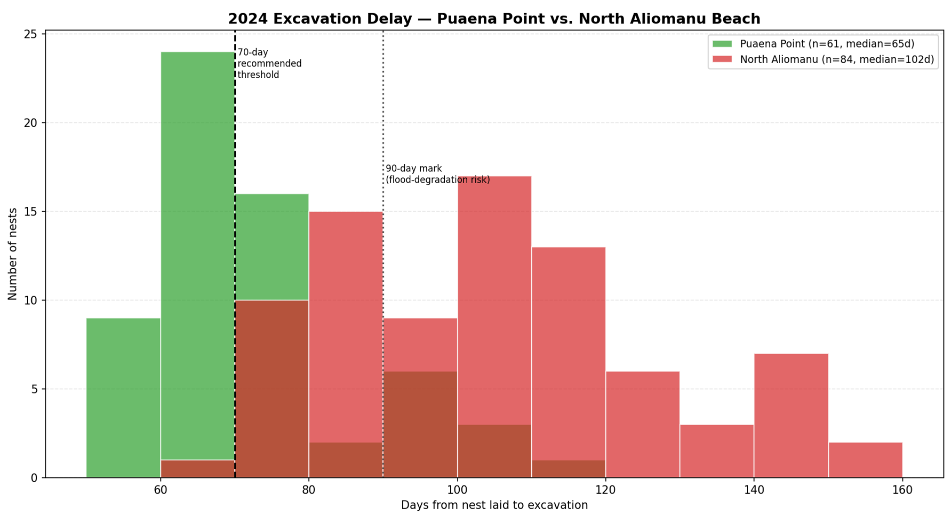

Figure 3. Distribution of excavation delay (nest-laid to excavation date), Puaena Point vs. North Aliomanu Beach, 2024. Puaena Point clusters tightly around the 60–80 day range; North Aliomanu is shifted well past the 90-day mark for most of its distribution, consistent with density forcing later excavation rather than a difference in practice between the two beaches.

Metric (2024 season)	Puaena Point	North Aliomanu Beach
Median delay, nest laid to excavation	65 days	**102 days**
Mean delay	72 days	105 days
Range	54–110 days	67–161 days
Sample size (n)	61	84
% excavated beyond 70-day threshold	43%	**98%**

% excavated beyond 90 days (flood-degradation risk)	16%	**67%**
Median delay, normal hatch date to excavation	**5 days**	**42 days**
% excavated before the normal hatch date had even arrived	**15%**	0%

The figures above measure delay from the date the nest was laid, but the disturbed-sand signal probing depends on comes from hatchling emergence, not from laying — so the more relevant clock starts at the normal hatch date (nest date plus 60 days, per this dataset's own "Norm Hatch" field), not the laying date. Measured that way, the contrast sharpens rather than softens: Puaena Point's median delay from normal hatch to excavation was just 5 days — remarkably prompt, and in fact 15% of its excavations happened before the normal hatch date had even arrived, which is a different and more premature problem than the 65-day-from-laying figure alone suggests. North Aliomanu's median delay from normal hatch to excavation was 42 days — six weeks for the sand signal to be repacked by flooding and nearby digging (above) after the actual event probing depends on, not the 102-day figure's already-substantial but less precise impression.

This means excavation-based ground truth is only as reliable as the excavation that produced it, and at a dense beach that reliability runs into the same problem twice: density forces the excavation to wait (this section), and the same wait gives a flood-prone environment time to erase the evidence being waited for. Puaena Point's spacing meant neither problem applied there in 2024, which is why it can serve as this report's validation reference; North Aliomanu's own 2024 excavation data cannot, for reasons tied to its density rather than whether its nests were real. This is part of why Section 8 concludes that reliable excavation-based ground truth cannot be established at North Aliomanu itself, and why this report instead treats Puaena Point's confirmed, low-disturbance result as the closest available check on the methodology.

Two different questions were checked against Puaena Point's ground truth, and they gave two different answers, which matters for how the result should be read. At the level of a single event — is this one nest real or a false crawl — the methodology reached 69% accuracy, the best of several configurations tested. At the level of grouping — when two real nests are placed in the same turtle's sequence, is that actually the same turtle — accuracy was far lower, 13–32% depending on configuration. These are not the same number describing the same thing: correctly sorting one event is easier than correctly linking two. Turtle count depends on the second, harder question, not the first, and it should be read accordingly — when Wave Capacity was removed in testing, Puaena Point's turtle count moved from 8 to 17 while the total nest count barely changed, which is a turtle-count swing of that size coming directly from how uncertain the grouping question is, not from anything about the beach itself changing.

The mechanism behind Puaena Point's numbers is identified and specific: a high volume of false crawls whose dates overlap the same 11–18-day rhythm as real nests, so date logic alone cannot reliably tell them apart. A beach without that specific problem — few or no false crawls competing for the same date windows — is not subject to this failure mode, and the same methodology should perform substantially better there. North Aliomanu is believed to have little to no comparable disturbance history this season, which is the basis for expecting its 98% raw assignment rate to reflect genuinely high accuracy rather than Puaena Point's gap between a similar-looking raw rate and much lower true accuracy.

That expectation is a well-grounded inference from the identified mechanism, not a second ground-truth validation. North Aliomanu does have 2024 excavation data, but for the reasons above it cannot currently serve as reliable ground truth there; no beach with both a comparably confirmed low-disturbance history and trustworthy excavation timing has been checked to confirm directly that accuracy holds up as expected. This is a gap in what can currently be verified, not a reason for doubt about North Aliomanu's numbers specifically — it is the reason this report distinguishes an estimate from a confirmed count throughout, and the reason continued excavation at lower-density beaches (Section 8), rather than any verification step at North Aliomanu itself, is this program's path to closing that gap over time.

This program is not in a position to independently resolve that remaining uncertainty for North Aliomanu using date data alone, no matter how the rules are tuned — and for the reasons in Section 8, this report does not treat post-season excavation or a grid survey at North Aliomanu itself as a viable path to resolving it either. A beach this dense cannot support the individual-nest attribution any excavation-based confirmation method would need, walked survey or otherwise.

This program's confirmable path instead runs through continued excavation at lower-density beaches, where nest spacing and site conditions support reliable attribution (Section 8): validating and refining this methodology against beaches like Puaena Point, as this report already does (Section 9), and folding future seasons' excavation-confirmed results in as they become available. For North Aliomanu specifically, absent a comparable low-disturbance beach's confirmed excavation ground truth, this report reports turtle and nest counts — including every count in this report for North Aliomanu — explicitly as the best current estimate under a validated, documented methodology, not as a confirmed figure. This report adopts this framing throughout; the Executive Summary and Conclusion state it directly.

This is not a reason to withhold or delay using the methodology at high-density beaches — the alternative, current practice there, has its own unresolved accuracy and disturbance concerns (Section 8). It is a reason to be precise about what a "turtle count" claim from this system means at a beach like North Aliomanu: the best available estimate under a validated methodology, checked against a comparable beach's ground truth rather than confirmed directly.

More broadly, this season's work suggests a repeatable cadence for using this toolkit across a full monitoring program, applicable to any beach with the same kind of date-and-location nest log:

When	What this toolkit does
~June 1 (season start)	Run the full identification methodology across all monitored beaches on the season's first few weeks of data to establish an early nest-density baseline per beach (as demonstrated for North Aliomanu in Section 2), flagging any beach whose early density or pace looks unusual relative to its own history.
Throughout the season	Re-run periodically at each beach and track the unassigned-nest rate. A beach with an unusually high or rising share of unassigned nests is a signal worth a field look — it can indicate a genuine data or monitoring issue (patrol gaps, mislabeled dates) as easily as unusual turtle behavior, and either is worth catching while the season is still active rather than after the fact.
Post-season, once excavation results are available	**Re-run with any excavation-confirmed "no eggs found" events excluded before chain-building, per the correction demonstrated at Puaena Point below. This produces a materially more accurate final-record assignment than the in-season, date-only pass, and is the version that should be used for year-over-year comparison where excavation data exists.**
Season end (all beaches)	Run a final all-beach pass — corrected where excavation data allows, date-only otherwise — and compare turtle counts, nest counts, and chain-length distributions year over year, the way Section 3 does for North Aliomanu across 2023–2026.

Open question on cadence timing: the season-start density baseline above is written as "~June 1," but the right calendar date is not yet settled and this report flags it for further consideration rather than treating it as decided. June 1 gives an earlier read but a smaller, noisier sample early in most beaches' seasons; July 1 gives roughly a month more data and a more stable early density estimate, at the cost of a later warning if a beach's pattern looks unusual. Both dates fall before excavation activity typically begins, so either choice preserves the baseline's intended purpose of reading density from patrol data alone, before any nest has been physically disturbed. This program has not yet run the comparison needed to recommend one over the other and treats it as an open methodological question rather than a settled choice.

An independent empirical anchor exists for the June 1 side of this question. Wetherall, Balazs, and Yong (1998), analyzing five years of saturation-survey data from tagged nesters at East Island, French Frigate Shoals, found that a 30-night survey beginning approximately June 1 gave satisfactory precision for their population estimators. That analysis optimized for a different objective — coverage-correction precision for a tag-based population estimator, not density-baseline stability for a date-only chain-matching method — so it should be read as suggestive rather than a direct validation of this program's own June 1 option. It is noted here as a data point for whichever calendar date this program ultimately settles on.

10. A Cultural Note

One piece of context outside this report's data, offered as reflection rather than a claim: in Hawaiian (Kanaka Maoli) tradition, Anahola is held by some to be where souls enter the world, and Polihale where they leave it. In 1994, the Dalai Lama visited Kauaʻi specifically to see both sites; accounts differ on whether he was expressing personal agreement with that belief or showing respect for it as a Native Hawaiian tradition, and this report does not attempt to resolve that distinction.

North Aliomanu Beach sits about a mile north of Anahola. This report does not know of any documented connection between the honu nesting there and the Anahola tradition specifically — but the honu holds a well-established place in Hawaiian tradition more broadly, as ʻaumākua, a family or personal guardian spirit, and it is not a large leap to imagine generations of hatchlings entering the sea a mile from a place already regarded as where souls enter the world leaving some mark on how that stretch of coast came to be understood. Offered here only as context for why this beach may matter beyond the data in this report.

11. Conclusion

For the complete 2026 season, which closed with its final nest on August 1, North Aliomanu Beach has 29 individually identified nesting turtles and 124 recorded nesting events. These figures are the best current estimates under a universal, documented methodology, checked against this report's validation reference (Puaena Point, 2024, Section 9) — a disturbed beach whose 2024 excavation data was the most reliable that year, where the same methodology reached 69% individual-event accuracy. North Aliomanu's own 2024 excavation data is not usable as a comparable check, for reasons tied to excavation delay and beach conditions rather than the identification methodology (Section 9). North Aliomanu is believed to lack a comparable disturbance history, so this methodology is expected to perform better there, but that expectation has not itself been confirmed against ground truth. These are accordingly reported as estimates, not confirmed counts. This report no longer recommends a post-season grid survey as the path to confirming them (Section 8): at this beach's density, a grid survey cannot reliably attribute recovered material to individual nests, and this program instead defers to studies conducted under more controlled conditions, such as those at Lalo (French Frigate Shoals), for excavation-based biological ground truth. Lower-density beaches remain a valuable source of that same excavation-based data, and continuing to collect it there (Section 8) is expected to further refine and validate this methodology over time. Basking observations, used as a behavioral proxy for accompaniment by a second (presumed male) turtle — no sex has been physically or genetically confirmed for any basking turtle — show a same-night match rate of 71% against a 53% baseline, restricted to nighttime hours during the nesting season. A meaningful subset of individually tracked females (10 of 29) show recurring Basking matches across multiple nesting nights, echoing similar basking with specified turtles also seen and documented in 2024. This is worth further investigation as a possible indicator of persistent accompaniment or small-group association across a nesting season, pending the individual identification and sex-determination data needed to confirm it.

Prepared using a rule-based nest-matching and observation-correlation methodology maintained across the 2026 season; full ruleset available on request.

12. References

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