Hampton Roads Itch Index (0–10)

A UV-style nuisance indicator from mosquito surveillance

Datathon 2025 – CDJ

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Abstract

We convert routine mosquito surveillance into a stable, interpretable *Itch Index* on a 0–10 scale so the public and operations teams can quickly choose protection levels for parks and green spaces. The index combines a saturating abundance transform, species bite-weights, recency with a 12-day half-life, and a small habitat multiplier from wetlands, then calibrates to a UV-style scale via rolling quantiles. We demonstrate regional trends, persistent hotspots, species drivers, and *park-level* scores using nearby traps, and we close with concrete actions for public messaging and vector control.

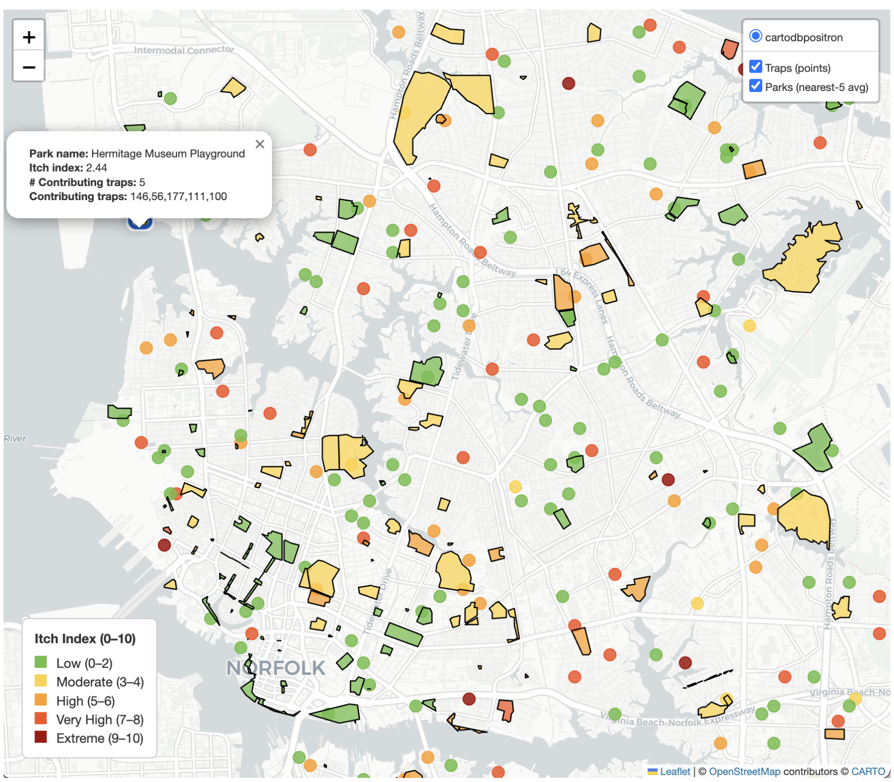

Figure 1: **Interactive Itch Map (click image).**

Figure 1 provides a clickable thumbnail that opens the live interactive map in your browser.

1 Problem statement and objectives

Biting nuisance is a leading driver of outdoor avoidance and complaints in Hampton Roads. Yet raw trap counts are hard to interpret and vary by method. Our goals were to design a biologically plausible, method-agnostic index, make it readable for non-experts (0–10), and publish a public map that can guide protection and operations.[1]

2 Data

Weekly mosquito trap counts by site, method, and species (BG-Sentinel, CDC light, gravid) come from the City of Norfolk open data portal; wetlands are from the National Wetlands Inventory and provide light habitat context.[23] Figures referenced below are produced by the repository scripts.

3 Methods

For each trap reading, we compute a base risk and map it to the 0–10 scale.

3.1 Abundance (saturating)

Let c be the total count from a trap visit. We compute

$$A = \frac{\sqrt{c}}{\sqrt{c} + K_t}, \tag{1}$$

where K_t is the 70th percentile of $\sqrt{c}$ within the same trap type $t \in \{\mathrm{BG}, \mathrm{Gravid}, \mathrm{CDC}\}$, ensuring comparability across methods and reflecting diminishing returns. The curve rises quickly at low counts (each additional mosquito is noticeable) and levels off, matching how human nuisance saturates.

3.2 Species bite-weights

Each taxon is assigned a bite-weight $w \in [0, 0.95]$ based on human-biting propensity (e.g., *Aedes albopictus* ≈ 0.95; *Aedes* spp. 0.9; *Anopheles* 0.7; *Culex* 0.6; males 0). Two sites with identical abundance can imply different nuisance: day-biting *Aedes* drive park/playground annoyance, while *Culex*/*Anopheles* raise dusk/twilight risk.

3.3 Recency

Recent catches matter more:

$$R = 0.5^{d/12}, \tag{2}$$

[1]Interactive Itch Map: `https://domsoos.github.io/itch_map.html`

[2]Mosquito Trap Counts (Norfolk): `https://data.norfolk.gov/Environment/Mosquito-Trap-Counts/wafq-k26c/about_data`.

[3]Hampton Roads NWI Wetlands: `https://data.virginia.gov/dataset/hampton-roads-nwi-wetlands/resource/b765ad70-828d-4204-acb7-a44f54a77f91`.

where d is days since the catch (12-day half-life). This down-weights stale information yet preserves memory across weekly trap cycles.

3.4 Habitat nudge

A small region-wide multiplier from wetlands,

$$H \in [0.95, 1.15], \tag{3}$$

nudges risk up or down with proximity to wetlands without overpowering the surveillance signal.

3.5 Base risk and calibration

The per-reading base is $B = A \times w \times R \times H$. To obtain a stable, readable 0–10 index, we apply a piecewise linear quantile mapping over the last 60 days (excluding males), anchoring $q_{10} \mapsto 2$, $q_{50} \mapsto 5$, $q_{90} \mapsto 8.5$, and $q_{99} \mapsto 10$ with linear interpolation between anchors; this keeps the scale stable across seasons while remaining responsive.

3.6 Regional heat grid (IDW)

For choropleths we build a coarse interpolation grid (˜500 m spacing). For grid point $\mathbf{x}_g$ we compute an inverse-distance weighted value from the latest trap readings,

$$\widehat{I}(\mathbf{x}_g) = \frac{\sum_i I_i \, d(\mathbf{x}_g, \mathbf{x}_i)^{-p}}{\sum_i d(\mathbf{x}_g, \mathbf{x}_i)^{-p}}, \quad p = 2,$$

using a tiny ε inside distances to avoid division by zero, and export `outputs/itch_index_heatgrid.csv`.

3.7 Park-level Itch from neighboring traps (nearest 5)

Decisions often happen *at the park*, not at a trap. We estimate a **park-level Itch Index** by blending the nearest trap readings: we load Norfolk parks (`Parks_-_City_of_Norfolk.geojson`) and reproject to metric units (`EPSG:3857`); take the **latest** Itch value at each trap, reproject those points, and assign each trap an integer label (Trap 1, Trap 2, . . .) for transparent popups; and for each park centroid we find the $k = 5$ **nearest traps** by Euclidean distance and compute an inverse-distance weighted mean:

$$I_{\text{park}} = \frac{\sum_{j=1}^{k} w_j I_j}{\sum_{j=1}^{k} w_j}, \text{where } w_j = (d_j + \varepsilon)^{-2}$$

. This results in a simple mean if weights degenerate. We store the number of contributing traps and their labels for traceability. The resulting park polygons include `itch_mean` (0–10) as the weighted score, `itch_n` (0–5) as the number of contributing traps, and `itch_trap_ids` as comma-separated labels, and we save the layer as `data/parks_itch_index.geojson` in WGS84 for web use. This approach lets nearby traps speak loudest, remains fast and transparent, and keeps parks on the same public 0–10 scale.

3.8 Interactive map layers

The published map exposes three coordinated layers that share band colors (Low → Extreme): point markers for traps colored by band with popups listing Itch value, address, species, date, count, and band-matched tips; polygon fills for parks colored by `itch_mean` with popups showing the score, number of contributing traps, and trap IDs; and a soft IDW grid backdrop for regional context, with legends and simple layer controls to keep the UI intuitive.

4 Results & discussion

Below we pair every figure with a short narrative: what it shows, how to read it, and what to do about it.

4.1 Regional trend (last 30 days)

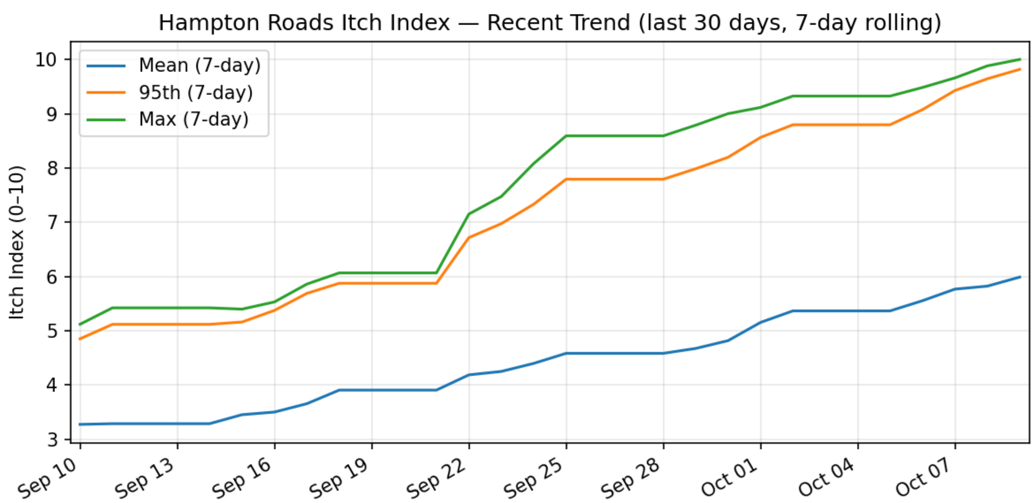

Figure 2: Seven-day rolling *mean*, 95th percentile, and *max* of the Itch Index across sites in the last 30 days.

As shown in Figure 2, the mean smooths daily noise, the 95th percentile tracks the upper tail across sites, and the maximum flags episodic spikes. When the 95th percentile pulls away from the mean, a few hotspots are rising above background, whereas convergence signals broad-based shifts; brief spikes in the max without movement in the 95th suggest isolated surges (e.g., post-rain pockets). Operationally, if the 95th persists in *Very High* while the mean is lower, prioritize targeted responses; if mean *and* 95th rise together, pivot to broader messaging and pre-event advisories.

4.2 Current distribution and bands

As shown in Figure 3, a histogram of the most recent Itch Index at each monitored location, with band thresholds, shows whether nuisance is concentrated or widespread. A center of mass in 3–6 implies widespread but manageable conditions where repellent and clothing guidance suffice, while

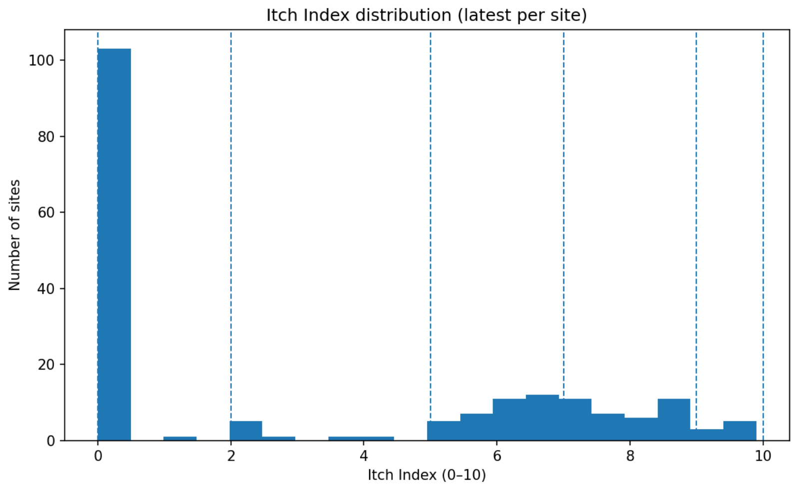

Figure 3: Distribution of the latest site scores with UV-style band markers (0–2 Low, 3–4 Moderate, 5–6 High, 7–8 Very High, 9–10 Extreme).

a heavy right tail into 7–10 points to conditions where targeted alerts or small timing adjustments for outdoor events may help; the share of sites in *Very High*/*Extreme* is a practical trigger for park signage and event emails, and the modal band can set the week's baseline public message.

4.3 Hotspot stability

Each point is a site with the recent 4-week average on the x-axis and the current value on the y-axis (see Figure 4). Clusters well above the diagonal indicate persistent or worsening hotspots; points near the axes (low recent, high current) suggest sudden flare-ups that may settle quickly. Abatement and extra surveillance should focus on sites that are high on average and still above the line, while cooling sites below the line are candidates to sunset temporary measures and redeploy resources.

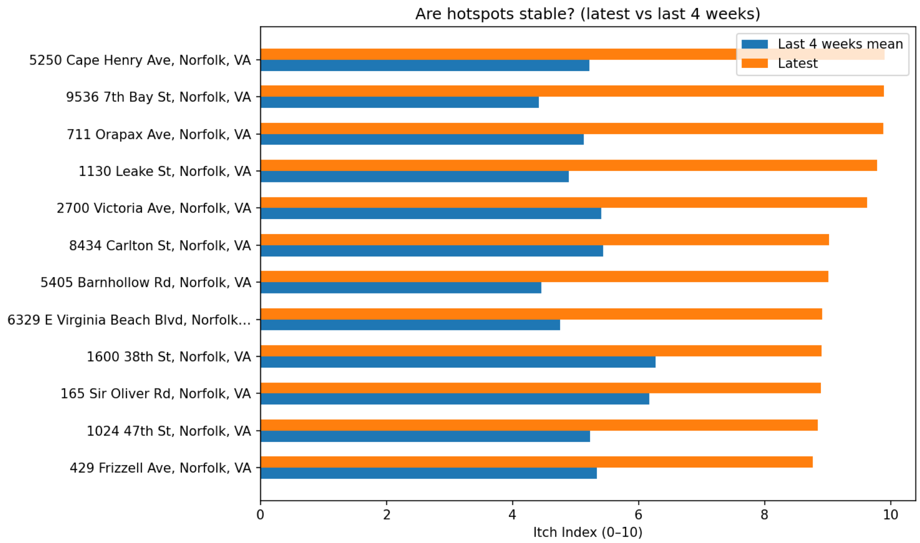

Figure 4: Site-level comparison: latest Itch Index vs. the mean over the previous 4 weeks at the *same* sites. Points above the 1:1 line are heating up; below are cooling.

4.4 What drives the itch? (last 30 days)

Figure 5 ranks species groups contributing to the bite-weighted signal, revealing whether day-biting *Aedes* or evening/twilight biters like *Culex* and *Anopheles* dominate; males are excluded. A large *Aedes* share calls for daytime protection and playground messaging, whereas a *Culex*/*Anopheles* tilt shifts emphasis to dusk/dawn activities and waterfront trails, informing whether to stress source reduction or adulticiding and where.

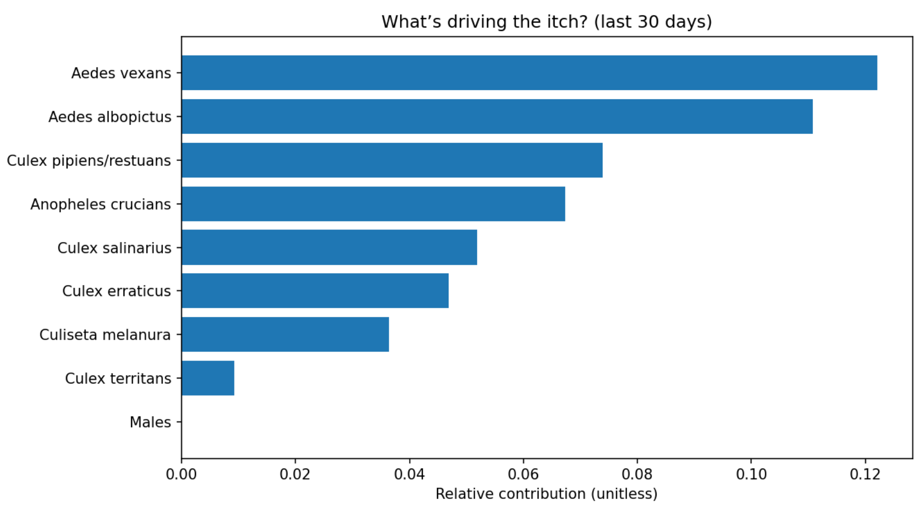

Figure 5: Relative contributions by taxa to the bite-weighted signal in the last 30 days.

4.5 Sanity check by trap type

Figure 6 compares distributions across BG, CDC light, and gravid traps after abundance transformation and trap-type normalization. Overlapping distributions indicate the method-agnostic goal is met; large systematic gaps would suggest calibration issues and motivate revisiting K_t estimation or sampling protocols, otherwise teams can confidently combine signals into a single public-facing number.

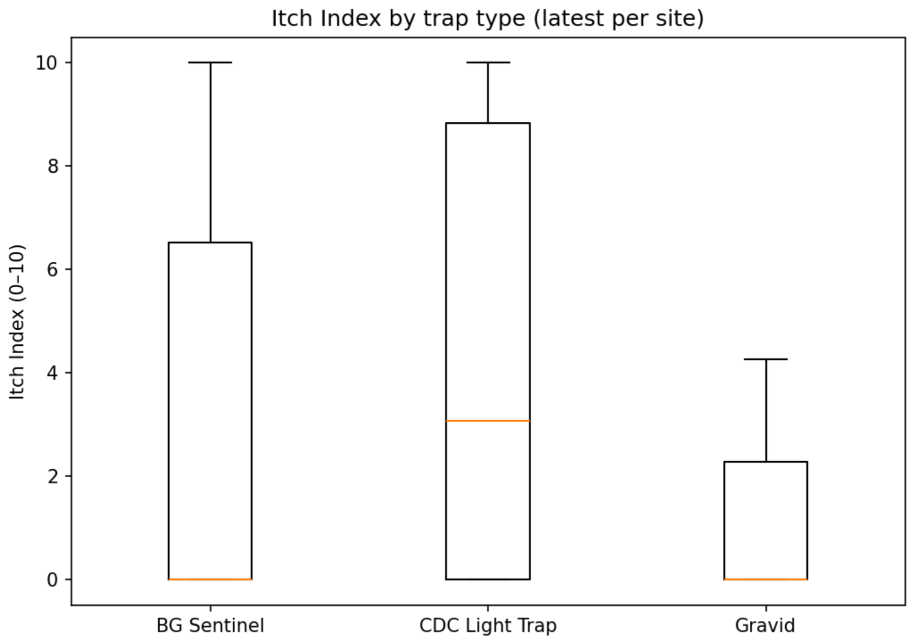

Figure 6: Distribution of the Itch Index by trap method (BG, CDC light, gravid).

4.6 Park layer: what to look for

Although the park layer is interactive, the takeaways are straightforward: parks shaded *Very High/Extreme* warrant stronger precautions on signage and in programming notes, and popups listing the number and identities of contributing traps help staff trace the signal and spot coverage gaps for future trap placement.

5 Interpretation and public guidance

Band guidance for the Itch Index

Band	Guidance
0–2 (Low)	Low nuisance risk.
3–4 (Moderate)	Repellent recommended at dusk/dawn.
5–6 (High)	Repellent + socks/long sleeves near vegetation.
7–8 (Very High)	Avoid marsh-edge trails at dusk; event caution.
9–10 (Extreme)	Strong protection; consider advisories.

6 Actionable recommendations

Target persistent hotspots by prioritizing sites in the top decile that remain above 7 for two consecutive weeks; tailor communications and operations to the dominant taxa, emphasizing daytime protection where *Aedes* dominates and evening protection where *Culex/Anopheles* are high; establish a weekly operational rhythm that uses the index to pre-position traps and crews and to brief Parks & Rec and event planners; and improve near-term nowcasting by adding recent rain, temperature, and humidity to bridge days between trap runs.

7 Limitations and next steps

Coverage remains incomplete because not all parks or sites are sampled weekly; recency weighting mitigates but does not eliminate gaps. The 0–10 mapping is anchored by rolling quantiles, so within-season values are comparable but are not raw counts. The habitat multiplier is intentionally small, and richer land cover and weather nowcasting are promising additions.

8 Reproducibility

Code and parameters are described in the repository. The calibration window (60 days) and anchors keep the scale stable while adapting to seasonal shifts. Species weights and the half-life can be tuned as new evidence arrives.

Live map: domsoos.github.io/datathon2025/itch_map.html
Source code & data: https://github.com/domsoos/datathon2025