Crab Team Sentinel Site Results Summary | 2022

Alex Stote, Benjamin Rubinoff, Emily Grason, and P. Sean McDonald
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Overview

Washington Sea Grant's Crab Team network includes 10 coastal "sentinel" sites distributed from Makah Bay (1 site) to Grays Harbor (4 sites) and Willapa Bay (5 sites). This year marked the third year of monitoring invasive European green crabs and native communities within these estuaries. For the first time in its three years running, the network achieved a 100% sample rate, meaning that all 10 sites were successfully monitored once a month from April through September 2022.

The sentinel site network represents an opportunity to build a long-term ecological monitoring dataset that can be used to observe native community trends over time while also tracking green crab population status and demographics at individual sites. While still in its infancy, we can learn a lot from the data collected from this monitoring network from 2020-2022. This results summary serves to explore the 2022 sentinel site data and, where possible, draws comparisons to previous years.

Acknowledgements

WSG would like to extend a sincere thank you to each of the sentinel site monitors, new and returning. Without the generous participation and adventurous spirit of our partners, this work wouldn't be possible: Brady's Oysters, Coastal Interpretive Center, Grays Harbor National Wildlife Refuge, Grays Harbor Stream Team, Makah Fisheries Department, Shoalwater Bay Indian Tribe Natural Resources, Taylor Shellfish, Washington Department of Fish and Wildlife, Willapa Bay National Wildlife Refuge, and the Willapa-Grays Harbor Oyster Growers' Association.

Sentinel Site Results

Species Composition

Across all sites, a total of 17 species of crustaceans (5), fishes (10), gastropods (1) and insects (1) were caught in traps during the 2022 sampling season (Table 1), and an additional crustacean species (*Hemigrapsus nudus*) was detected during the molt surveys (Table 2). As with last year, hairy shore crab (*Hemigrapsus oregonensis*) was the most numerous species in the traps, followed by staghorn sculpin (*Leptocottus armatus*) and three-spined stickleback (*Gasterosteus aculeatus*). Green crab was the fourth most numerous species captured, and it was detected at all sites except for Dohman Creek, the southernmost site in Willapa Bay and part of the Willapa National Wildlife Refuge. The only species that was caught at all ten of the sites was the staghorn sculpin. Notably, hairy shore crab was not captured at all sites this year– Nahcotta, the site with the highest abundance of green crab, did not capture any hairy shore crabs, and no hairy shore crab molts were collected during surveys. In fact, this site caught no species of crustaceans other than green crab, though they did observe one Dungeness crab molt over the course of the season (Table 2). While we cannot confidently infer a causal relationship between high abundance of green crab and absence of other live crab species, given the documented negative impacts of green crab on native hairy shore crabs in other parts of the west coast range, this observation raises concern that green crabs could already be impacting the shore crab population at this site.

Five new species were captured for the first time in the coastal monitoring surveys: signal crayfish (*Pacifastacus leniusculus*), an unidentified species of flatfish, tidepool sculpin (*Oligocottus maculosus*), giant water bug (*Lethocerus americanus*), and Olympic mudminnow (*Novumbra hubbsi*), a species listed as "sensitive" in Washington. Several of these species are freshwater obligate, and likely only uncommon, and possibly unintentional, visitors to these estuarine sites, so their capture might be somewhat incidental. Indeed, these freshwater species, the crayfish, the water bug and the mudminnow, were all captured at sites with significant and directional stream inflow.

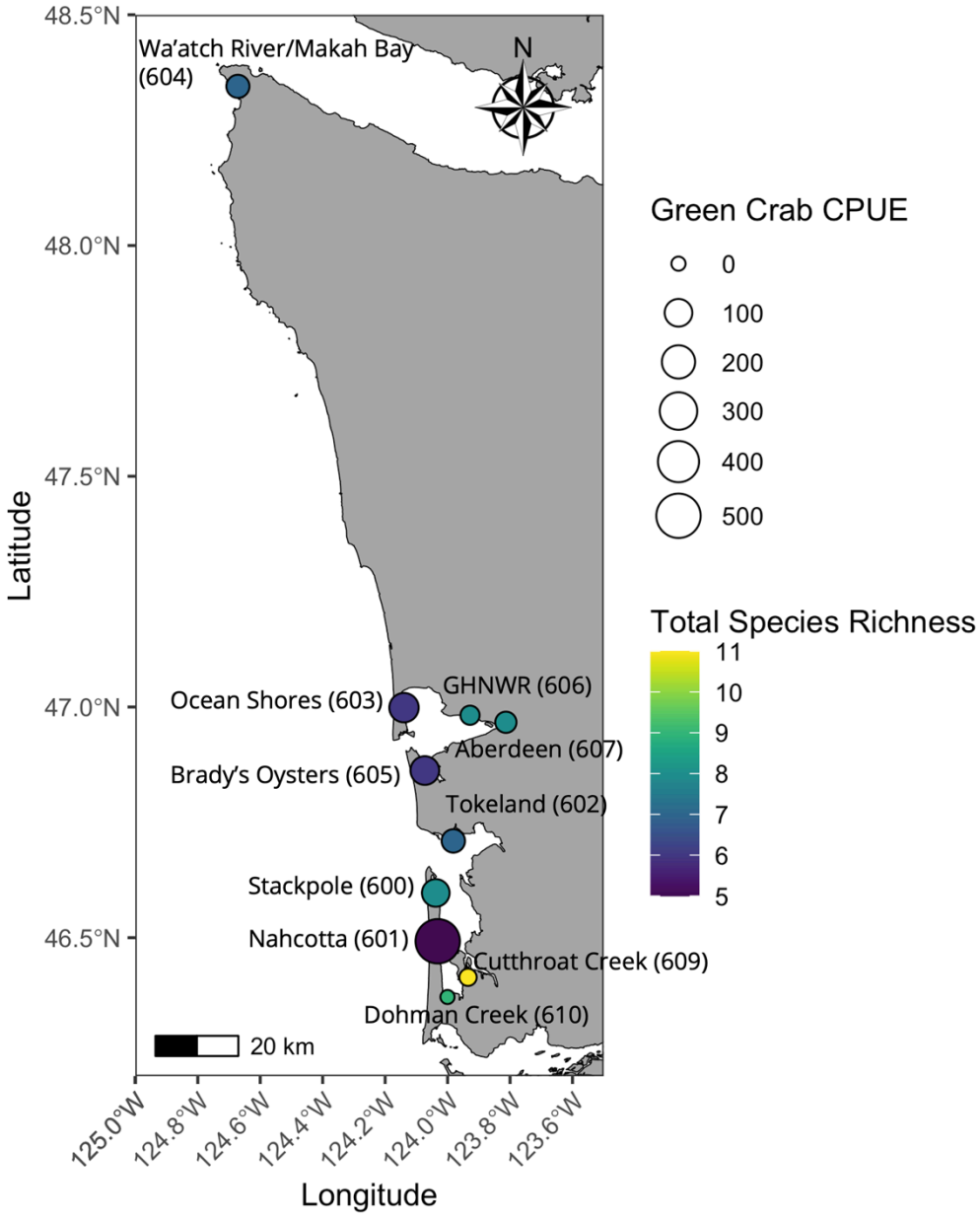

Figure 1. *Total green crab relative abundance, shown as catch-per-unit-effort (number of crabs per 100 traps set), and species richness at each site in 2022.*

Cutthroat Creek, in southern Willapa Bay, had the greatest species richness (the number of distinct species detected during trapping) of all the sites, capturing a total of 11 species, two of which were found only at

that site (Table 1, Figure 1). When examining species richness in conjunction with green crab relative abundance, sites that had high species richness tended to have lower abundances of green crabs (e.g. Dohman and Cutthroat Creeks) (Figure 1). Conversely, sites with higher abundances of green crab generally tended to have lower species richness (e.g. Nahcotta, Brady's Oysters, and Ocean Shores). There are several possible explanations for this association we cannot currently distinguish among with available data. While it is possible that high abundances of green crabs cause lower species richness within a site based on these data, it is also possible that lower species richness could *allow* green crabs to establish more easily. Additionally, there might be environmental factors that influence both native species richness, and green crab abundance independently of each other. For example, Dohman and Cutthroat Creeks are up-estuary sites, meaning they have more frequent visitation from freshwater species, which helps to inflate their species richness (Figure 1). Notably patterns of circulation within Willapa have likely limited substantial recruitment of green crab in those up-estuary sites to date. As numbers grow elsewhere in Willapa Bay, we might anticipate higher recruitment of EGC to those sites and patterns could change, or they may stay the same. In a nutshell, it is likely too early to tell if richness impacts invasibility by green crab, or if green crab impacts richness at a site, or if any correlation is spurious.

European Green Crab Captures

Abundance and Distribution

Relative abundance of green crab (CPUE, "catch-per-unit-effort"), standardized as the average number of crabs caught per 100 trap sets, varied by several orders of magnitude across sites, ranging from a low of CPUE = 0 at Dohman Creek to a high of CPUE = 503 at Nahcotta (Table 1, Figure 1). Ocean Shores had the second highest relative abundance of green crab with a CPUE = 128. Control trapping efforts outside of sentinel site monitoring have shown Tokeland to be a high abundance region for green crab, and while the sentinel site trapping averages are lower than what we might expect for this region, this is the site that found the greatest number of green crab molts and dead crabs (n = 42, or ~40% of all molts/dead found for this location) (Table 2).

Sex Ratios

Consistent with what is known about green crab trapping from other parts of the world, green crab captures were male-biased averaged across the season at all sites (78% male), though sites exhibited different patterns (Figure 2). For example, while Nahcotta consistently captured mostly male crabs (~90% male), the Wa'atch River in Makah Bay had a relatively even distribution of males to females through most of the sampling season. Ocean Shores exhibited a seasonality in male captures, with male abundances peaking in June but trending towards a more even distribution in the earlier and later months of sampling. At three sites, only female crabs were captured during September sampling - though admittedly capture rates were very low (1-3 CAMA total) in those samples. Anecdotally, coastal trapping groups outside of the sentinel site network report catching females at higher rates in September and October compared to the rest of the year. Sentinel sites generally appeared to follow this trend in September, except for Nahcotta, the Grays Harbor National Wildlife Refuge, and Aberdeen.

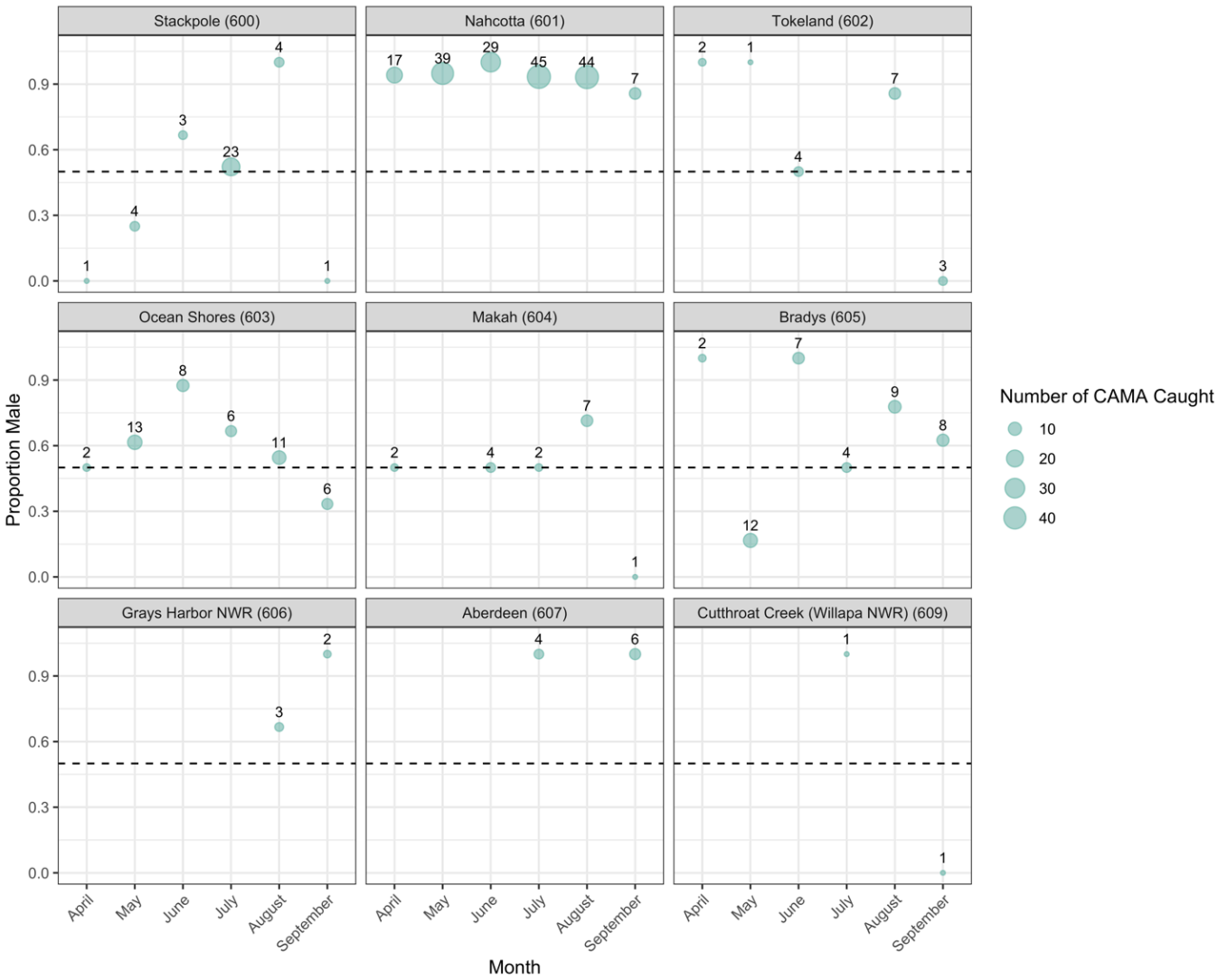

Figure 2. *Sex ratio of European green crabs (*Carcinus maenas*) in sentinel traps by site and by month. Numbers above the points represent the total CAMA captured for that site and month, and the dotted line represents an equal proportion of males to females.*

Size and Recruitment Patterns

Size data is used to track age classes of green crabs within the estuaries, and this information can provide insight into how long crabs have been settled at a location, as well as the strength and timing of recruitment. In molt surveys, green crabs spanned 11 mm to 59 mm and those in sentinel traps ranged from 15 mm to 95 mm, indicating that multiple age classes, from young-of-the-year (YOY) to 4-5+, are present within the monitored estuaries (Figure 3). Using the conservative benchmark size of 30 mm as a cutoff, YOY crabs comprised at least 13% of the live green crabs trapped in 2022, which is about double of what was captured at sentinel sites during the previous year. YOY molts comprised ~44% of the molts measured.

When looking at site-specific crab sizes, the timing of YOY appearance in traps did not suggest a single seasonal recruitment pulse in 2022 (Figure 3). Similarly, in 2021 (see last year's report), young crabs were found across the entire sampling season, either as molts or live crabs. Taken together, these observations suggest that, in contrast to previous years, and patterns within coastal estuaries do not experience a single recruitment event each year. This year's data also support the notion that dynamics of the estuary likely

influence where settlement occurs. For example, in Willapa Bay, both Stackpole and Tokeland had young crabs present throughout the season, with one larger pulse of small crabs in July. Meanwhile, Nahcotta and Cutthroat Creek captured only large live crabs, though they each logged at least one YOY molt. This suggests a trend in Willapa Bay in 2022 that sites closer to the mouth of the bay (i.e. Stackpole & Tokeland) had more recruits/small crabs than sites further into the bay (i.e. Nahcotta & Cutthroat Creek). In Grays Harbor, a similar trend appeared where sites furthest from the mouth (Grays Harbor National Wildlife Refuge and Aberdeen) recorded only large adult crabs. The sites closest to the mouth (Ocean Shores and Brady's Oysters) recorded smaller crabs.

While there appeared to be no distinct timing of recruitment in Willapa Bay and Grays Harbor, the Wa'atch River in Makah Bay told a different story. The molt and capture data clearly outline an early YOY of cohort that is visible as molts in April-June and as live captures in June-August. In September, a second pulse of a late-season YOY cohort appears in surveys as molts, perhaps pointing to two distinct recruitment phases in this bay (Figure 3).

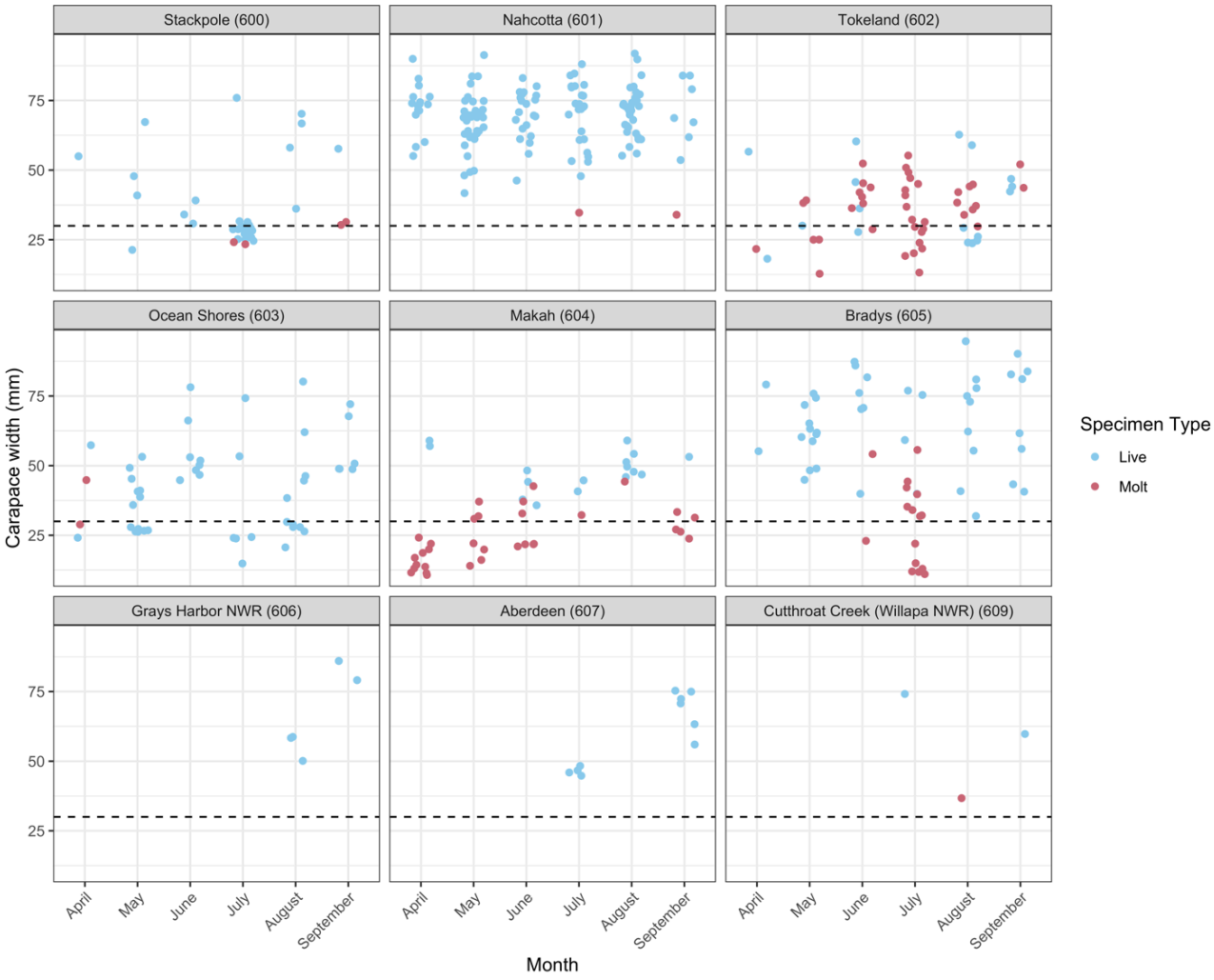

Figure 3. *Size of European green crabs (*Carcinus maenas*) captured in traps and collected as molts/dead by site and by month. The dotted line is at n = 30mm, which is a general cutoff for young of the year size early in the season. In the later months (August and beyond) young of the year crabs can be in the low 40mm range, if they are part of an early-season cohort.*

Seasonal Patterns

Capture rates were highest in July and August, and rates generally increased across sites in the second half of the season, from July through September (Figure 4). There were two notable exceptions, however, at Ocean Shores and Brady's Oysters, the two sites located closest to the mouth of Grays Harbor. Those two sites followed an almost identical trajectory in seasonal patterns throughout the season, with greatest captures peaking in May and remaining relatively consistent through September (Figure 4). Meanwhile, Nahcotta and Stackpole, both located on the Long Beach Peninsula in Willapa Bay, logged a noticeable uptick in green crab captures from June to July, while the Wa'atch in Makah Bay experienced its greatest rate increase from July to August. The catch rates at Tokeland (Willapa Bay) remained consistent throughout the sampling period. Sites with relatively low green crab abundance (Aberdeen, Grays Harbor National Wildlife Refuge, and Cutthroat Creek) captured all green crabs in the second half of the season (July – September) (Figure 4).

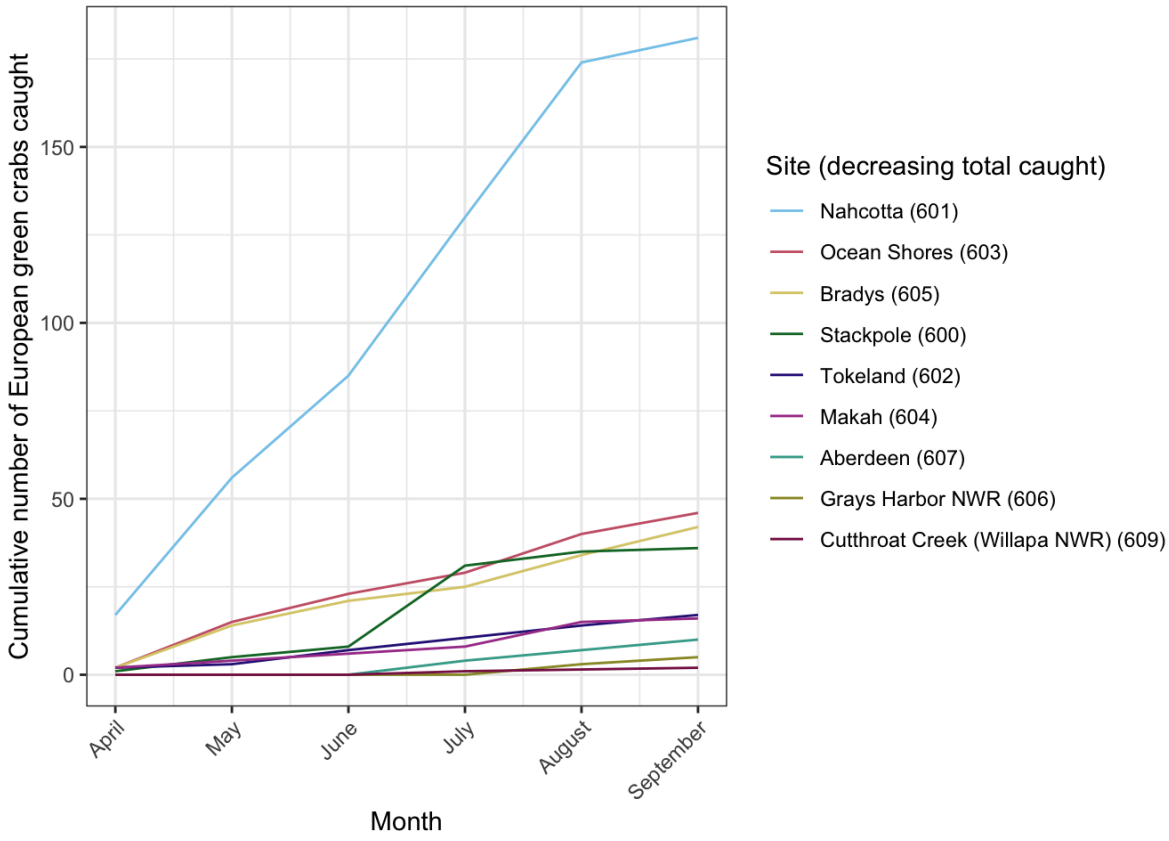

Figure 4. *Cumulative total of European green crabs at sentinel sites from April through September. The legend order matches the order of sites in which they appear from top to bottom, or in decreasing abundance.*

Annual Trends

Looking across sites and within water bodies, no clear patterns emerge for green crab population change across space (Figure 5). Site-specific changes from 2020 to 2022 are apparent but are not consistent within water bodies or across the network. Most notably, the catch-per-unit-effort increased dramatically from 2020-2022 at Nahcotta, but at other sites populations either increased only slightly (Stackpole), decreased (Tokeland, Cutthroat Creek, Ocean Shores, Aberdeen, and Wa'atch/Makah Bay), or stayed about the same (Brady's Oysters, Grays Harbor National Wildlife Refuge). It is challenging to interpret population trends from three years of data alone, especially when the changes for sites within the same water body do not suggest the same trends. Considering this interannual data alongside crab demographics such as size can help reveal other pieces of the story. For example, crab sizes, on average,

were relatively small this year at Tokeland compared to other sites – particularly missing were the largest crabs that were captured at other sites with similarly high capture rates (Figure 3), and that the average catch rate was lower this year (Figure 5). This could indicate that extensive removal trapping efforts that have been regularly occurring in the Tokeland region since 2021 are starting to impact the population size. Trapping typically removes larger adult crabs first, so a decreased average crab size, combined with a decreased average catch rate, could indicate that extensive trapping outside of the sentinel site is working to lower the adult population in Tokeland. At other sites where capture rates decreased this year, it is hard to pinpoint what may have caused slight declines. One reasonable explanation could be environmental conditions related to a La Niña year (negative ENSO indices). The winter months before the trapping season were colder and wetter than usual and bled into a cooler and longer spring. This may have created conditions that were either a) unfavorable to juvenile green crab survival and/or b) not conducive to entice crabs to traps, particularly in the earlier months of the season where capture rates were low (Figure 4). Continuing to build on this dataset in the future will allow us to continue to track and better understand green crab population trends over space and time.

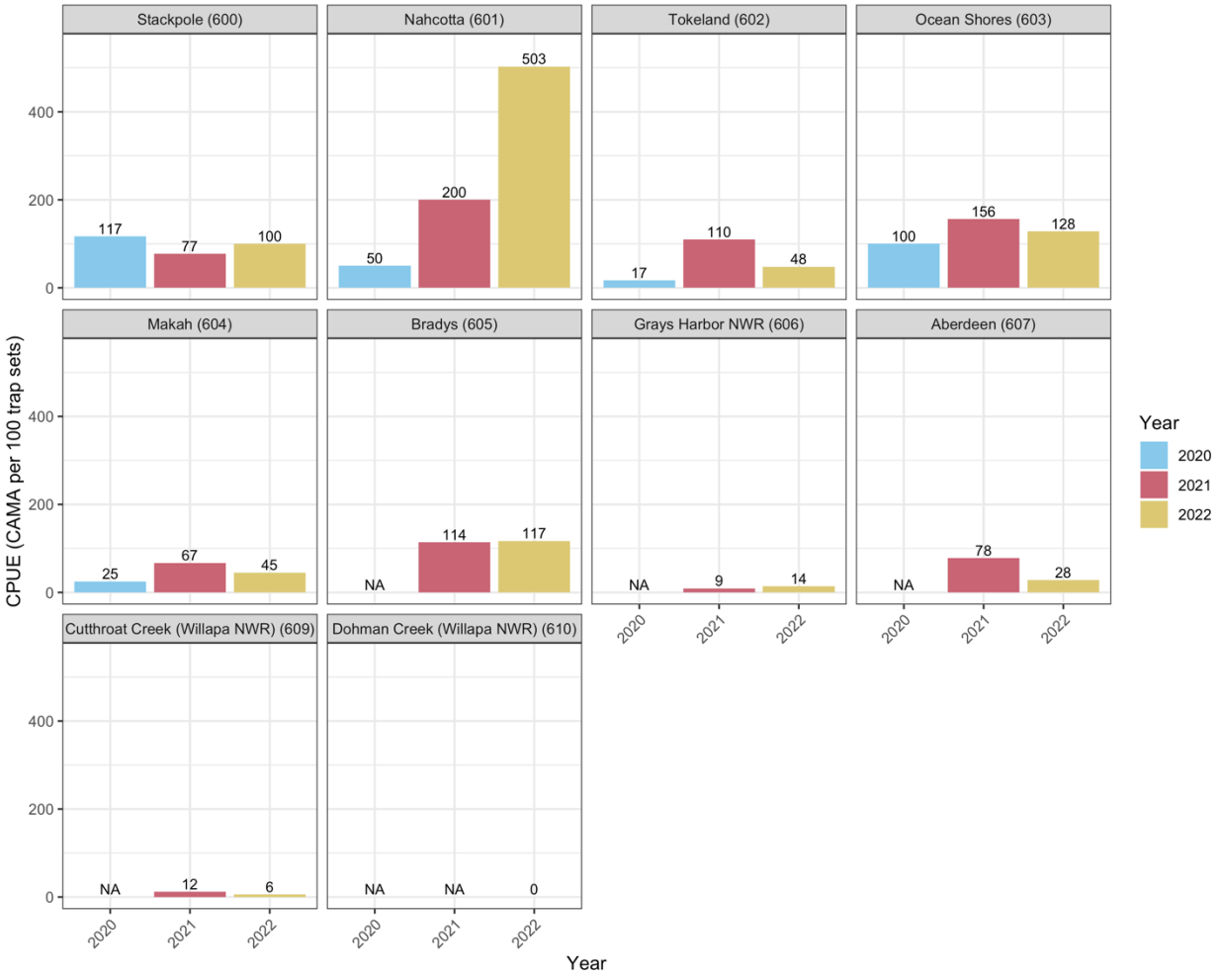

Figure 5. *Inter-annual comparisons of average green crab capture rates from 2020 to 2022. Note that for sites showing 2020 data, only August and September were sampled that year. In 2021, Stackpole was sampled for 5/6 months (all months except August), and Wa'atch/Makah Bay was sampled in April only.*