Alaska Whale FOUNDATION

ANNUAL RESEARCH REPORT

2023

A Season in Review

Since 2021, Alaska Whale Foundation (AWF) has been producing annual research reports that summarize our field efforts with an emphasis on the results from our whale monitoring program.

The results in these reports are preliminary; many form the basis of ongoing graduate student and/or collaborative research projects and will be subjected to more formal analyses in the coming months. Our goal here is to provide a broad overview of the trends we observed during the preceding foraging season for research partners, colleagues, and other stakeholders. As well, we provide updates on ongoing analyses and introduce some of AWF's new research initiatives.

Brief Overview of Research Protocols

AWF began conducting dedicated humpback whale surveys in Southeast Alaska in 2016.

Initially, these were part of a three-year collaborative project - Survey of Population Level Indices for Southeast Alaska Humpbacks (SPLISH) - with researchers from the National Oceanic and Atmospheric Administration's Auke Bay Labs, Glacier Bay National Park and Preserve (GBNPP), University of Alaska Fairbanks, and University of Alaska Southeast.

Each year during the SPLISH project, AWF conducted a single two-week, mid-summer photo-identification survey in the waters of central Chatham Strait, Frederick Sound, and lower Stephens Passage concurrent with project partners working in other areas to provide an annual snapshot of whale abundance, distribution, and calf production.

The results from those initial years revealed troubling declines in whale numbers, record-low calf sightings, and an increase in the number of whales in poor body condition, which have since been linked to the 2013-2016 Pacific Marine Heatwave (PMH).

The SPLISH project ended in 2018, but by then it had become clear that continued monitoring was vital to track how changing ocean conditions were impacting whales. Accordingly, we began conducting photo-identification surveys each month from June through September and expanded our study region to fill in many of the gaps throughout the inside waters of northern Southeast AK where data were lacking **(Figure 1).** We also added several new initiatives as part of a Strategic Partnership between AWF and the University of Hawaii at Manoa's Marine Mammal Research Program (MMRP) co-lead by AWF and MMRP Directors, Drs. Andy Szabo and Lars Bejder, respectively. These included Unoccupied Aerial System (drone)-based body condition sampling, biopsy tissue sampling for hormone, diet, and genetic analyses, and suction-cup tagging in both Alaska and Hawaii and in all months of the year.

In doing so, we have created one of the world's largest and most comprehensive, ocean-basic scale humpback whale health research programs. Most importantly, we are now in a far better position to track how Alaska's whales are faring as their coastal habitats are impacted by warming oceans.

A Quick Look at Whales in 2023

The number of unique whales we encountered in 2023 was higher than any other year since we began conducting systematic surveys in 2016; however, when controlled for year-to-year differences in spatial and temporal sampling effort, daily encounter rates were lower than three of the past five years.

Once again, birth rates remained far lower than in 2020, but an order of magnitude higher than the years coincident with and immediately following the Pacific Marine Heatwave (2013-2016).

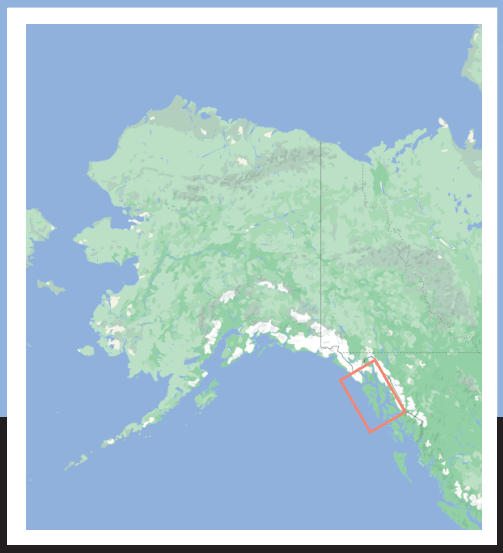


Figure 1.
AWF's study site in Southeast Alaska. The region within the dashed lines represents the areas surveyed by AWF during the SPLISH project from 2016-2018.

Situated in a remote bay on Baranof Island, our field station is a permanent base for scientific study and ecological monitoring, and invests in future generations of impassioned researchers by providing opportunities for student engagement.

Our field station is situated on Lingít Aaní (Tlingit land) and we recognize and respect the Tlingit community as the first inhabitants of our study area.

Whale Numbers

AN UPDATE ON WHALE ABUNDANCE IN ALASKA

Every month from late spring through fall, AWF conducts systematic surveys for whales throughout northern Southeast Alaska to estimate how many whales forage in the region each year and to track seasonal movement patterns.

So how did the whales fare in 2023?

From late May to late September, the AWF field team collected 968 photo-identification images of 627 unique humpback whales. In absolute terms, this is the highest number of unique whales we have encountered in a single year since starting our monitoring efforts in 2016 **(Table 1).** This occurred despite inclement weather that limited our ability to survey Frederick Sound and Stephens Passage in September, two connected bodies of water that traditionally have a high abundance of whales at that time of year.

However, there are caveats to consider when interpreting these data. When viewed as an average daily count of unique whales across each field season, which partially controls for year-to-year differences in survey effort, whale numbers in 2023 were similar to 2020 and considerably lower than in 2016. Furthermore, if we consider only the date from Frederick Sound and central Chatham Strait in late July/early August to match our limited efforts during the SPLISH project, our daily encounter rate was substantially lower than 2016 and 2019-2021 and only marginally higher than 2022 **(Figure 2).**

Year	Field days	Total IDs	Unique Whales	Calves
2016	5	124	110	2
2017	6	75	72	1
2018	32	317	220	2
2019	54	1327	578	22
2020	27	698	422	47
2021	49	1344	558	24
2022	45	1672	531	11
2023	44	968	627	28

Table 1. *Whales observed during systemic monitoring efforts, from 2016-2023.*

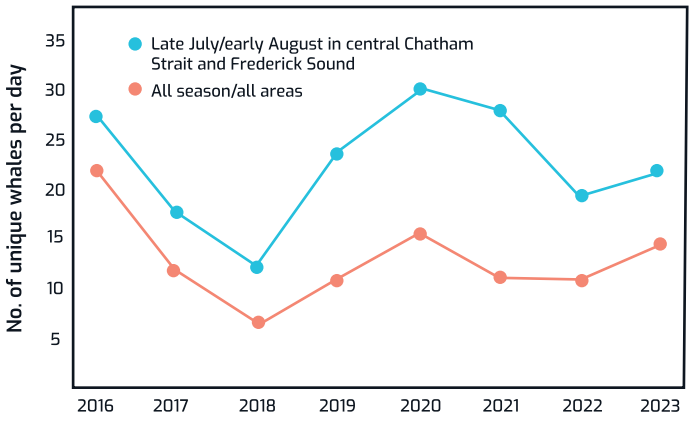


Figure 2. *Average daily numbers of unique whales photo-identified across AWF's full field season (red) and during late July/early August surveys in Chatham Strait and Frederick Sound only (blue).*

Yet this, too, should be interpreted with caution as the spatially and temporally limited snapshot can be influenced by comparatively small year-to-year differences in whale movement patterns. This is evident from a preliminary analysis of data from our whale abundance and distribution surveys between 2021-2023. During these surveys, we conducted point counts for whales each month from June through September at ~100 stations.

The distribution of these stations was established to provide nearly complete coverage of our study area. Using a Distance Sampling framework (Buckland et al. 2001; **Figure 3)** and analysis of monthly distribution plots **(Figure 4)**, we found that whale abundance increased significantly through August in the areas we surveyed during the SPLISH project (i.e., in all years).

This appeared to be driven by whales moving from both northern (Icy Strait, North Chatham Strait) and southern (South Chatham Strait) areas. We also observed consistent, but ephemeral 'hotspots' (e.g., Tebenkof Bay) where large aggregations of whales were predictably found at certain times during the summer foraging season.

These preliminary results highlight seasonally important feeding areas and underlying humpback whale movement patterns within the inshore waters of Southeast Alaska. They also reveal that even a comparatively small

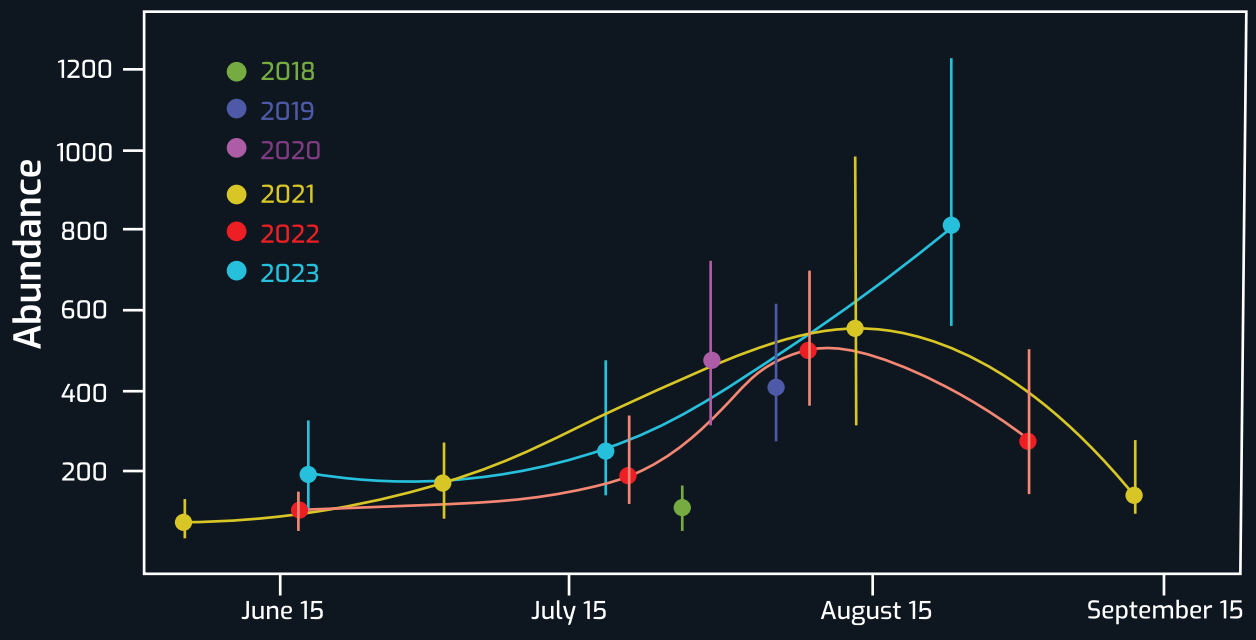


Figure 3.
Estimates of whale abundance from a Distance Sampling analysis for each year from 2021 - 2023 in Frederick Sound, Chatham Strait and Stephens Passage.

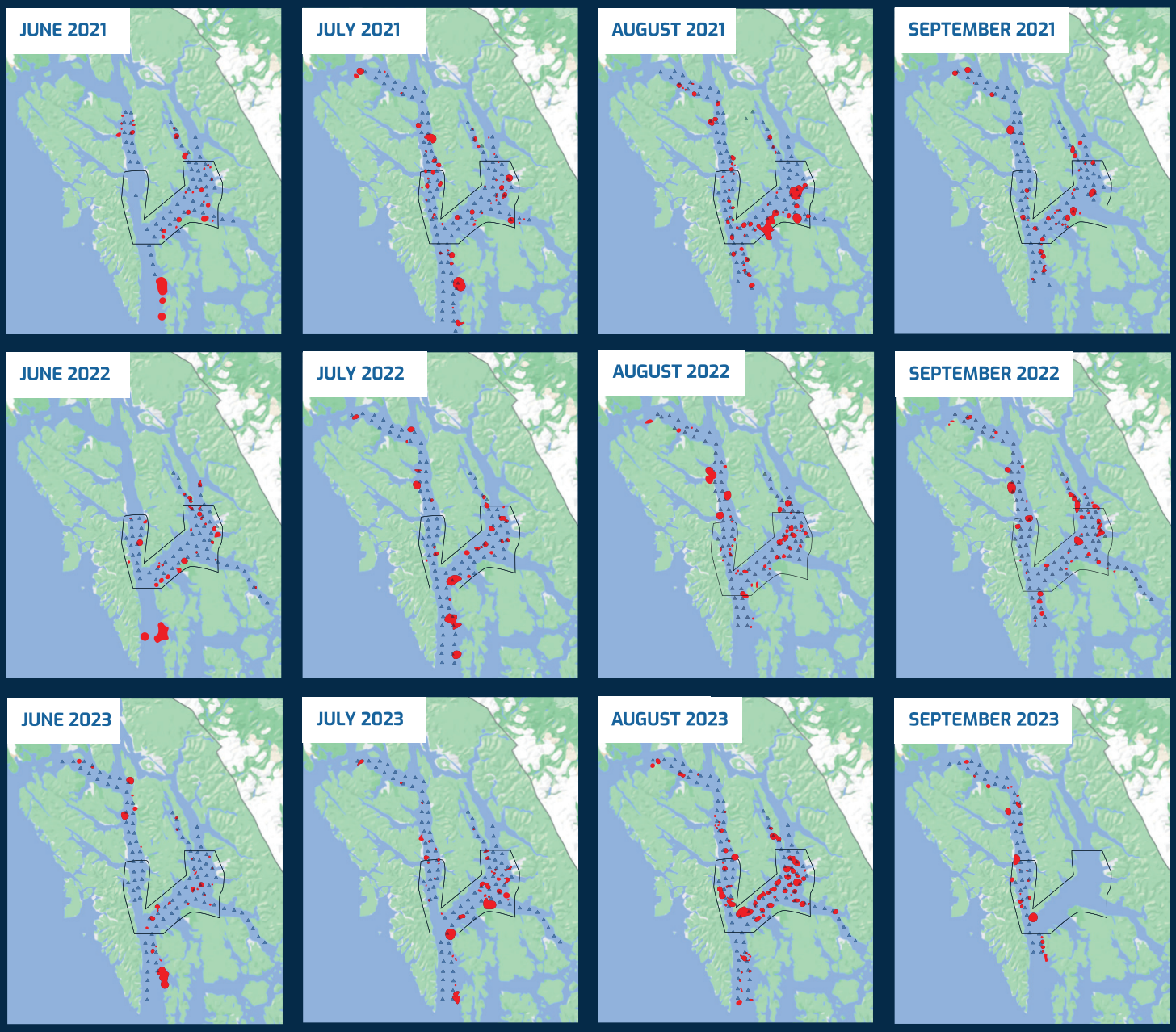


Figure 4.
Distribution of whales (circles) from photo-identification efforts between June and September in 2021 (upper row), 2022 (middle row) and 2023 (lower row). Circle size reflects group size. Triangles represent Point Count stations that were surveyed in each month and approximate spatial effort for that month; differences reflect variation in effort due to weather constraints. The area bounded by the black polygon has been surveyed every year since 2016.

shift in the timing of our mid-season efforts - e.g., from the last half of July to the first half of August – that can result from weather constraints can substantially influence the number of animals we encounter during those efforts.

As a result, year-to-year differences observed during these snapshots could reflect changes in the timing of arrival to specific areas rather than underlying annual abundance patterns for the region. A formal Distance Analysis using data from all months, in all years, and in all areas alongside a photo-ID-based Mark-Recapture analysis is currently underway to provide greater insight into movement patterns, a more robust estimate of annual abundance trends, and a better estimate of the size of the humpback whale population in our study area.

Since 2016, we have also been tracking calving rates **(Figure 5).** Both calf numbers and Crude Birth Rate (i.e., number of calves divided by number of adults; CBR) were lowest in the years coincident with and immediately following the PMH. Notably, the numbers of calves observed in 2016-2018 were an order of magnitude lower than in all subsequent years. This was mirrored in GBNPP; however, calf numbers in GBNPP did not increase substantially until 2020 (Neilson et al., 2023), a year after we began to detect an increase in our study region. As well, at its

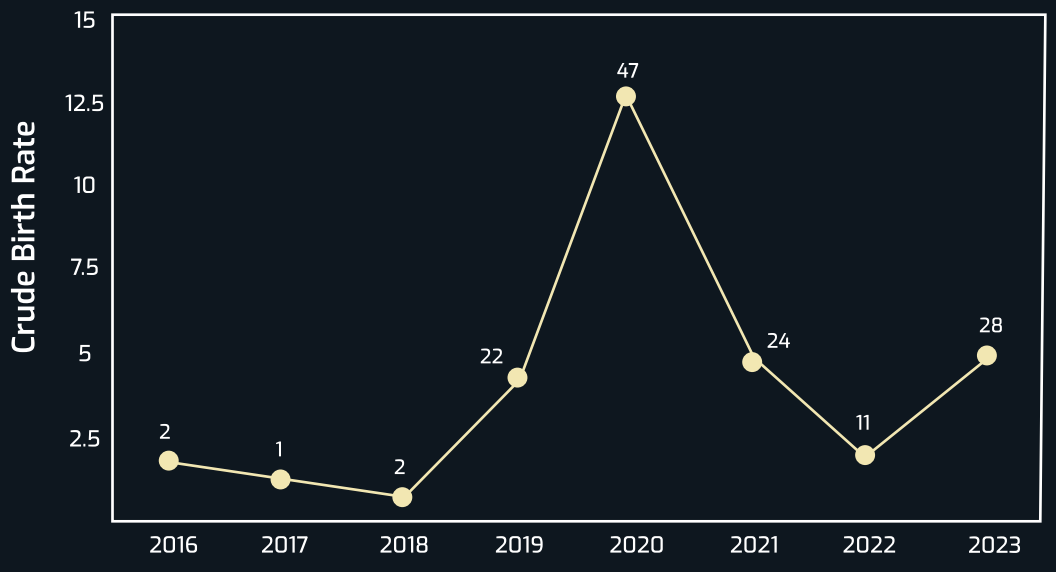
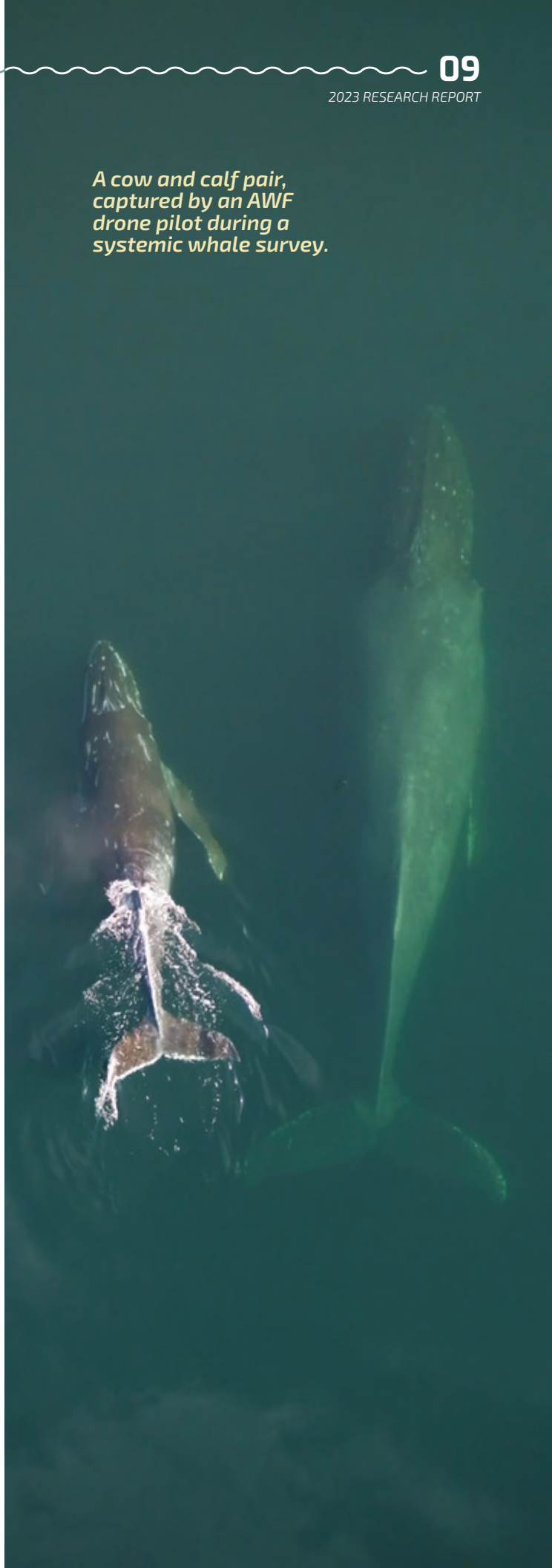


Figure 5.
Crude Birth Rate (i.e., the number of calves / number of adults) in AWF's study region from 2016-2023. Annual calf count is represented above the line.

peak in 2020 CBR for our study region (12.5%) was considerably higher than that observed for GBNPP (7.5%) and well above the mean for all years in GBNPP prior to the heatwave (9.3%; Neilson & Gabriele, 2021).

In 2023, we encountered 28 unique mother-calf pairs, which is second only to 2020; however, CBR was similar to 2019 and 2021 **(Figure 5).** When viewed from 2018 onward, a 2-year interval between high and low calving rates can be seen. Whether this apparent trend will continue remains to be seen, but if so it could result from year-to-year variability in ocean productivity, the average 2-3 year calving interval together with breeding synchrony triggered by improving ocean conditions following the PMH, or both.

Approximately, 75% of the whales we photo-identified in 2023 could be linked to a breeding ground using publicly available data from happywhale.com. Of these, 86% were linked to Hawaii, 11% were linked to Mexico, whereas the remaining 3% have been observed in different years in both Hawaii and Mexico. None of the whales we photo-identified were linked to either the Central America or Western Pacific breeding grounds.



A cow and calf pair, captured by an AWF drone pilot during a systemic whale survey.

Body Condition

AN UPDATE ON WHALE HEALTH

AWF researchers use Unoccupied Aerial Systems ("drones") to measure the body volume of individual whales. A whale's body volume reflects its blubber (i.e., energy) stores and is therefore a valuable proxy for its general health.

Body condition (BC) carries important implications for individual- and population-level survival and reproduction.

Animals in robust condition can maintain greater resilience and survival than animals in poorer condition (Clutton-Brock & Sheldon, 2010). As well, maternal BC influences reproductive success in baleen whales, with energetic investment in offspring affecting pre- and post-natal development rates (Lockyer et al. 2007; Christiansen et al. 2018). Recent advances in Unoccupied Aerial System (UAS; 'drone') technology, together with aerial photogrammetry provide a powerful, non-invasive approach to using measurements of a whale's body size as a proxy for body condition and overall health (Miller et al. 2012, Christiansen et al. 2016; Christiansen et al. 2020).

AWF partnered with the University of Hawaii at Manoa's Marine Mammal Research Program (MMRP) in 2018 to begin widespread drone-based body condition sampling in both Hawaii and Alaska. Led by graduate student Martin van Aswegen (MMRP), we have since collected approximately 6,000 and 3,300 BC measurements from whales in Hawaii and Alaska, respectively. In 2023, we sampled ~420 humpback whales in Southeast Alaska, including 16 mother-calf pairs.

Processing our 2023 data is underway; however, van Aswegen has conducted a preliminary analysis of BC data collected in Southeast Alaska between 2019-2022 to provide a first look at seasonal and annual body condition trends during those years.

Using body length and sighting history data, van Aswegen partitioned 1,965 measurements of 845 unique individuals into age and reproductive classes (calves, immature and mature whales of unknown sex and lactating females). Lactating females consistently exhibited the lowest and most variable BC of all reproductive classes, which presumably reflects the high energetic demands of lactation.

Among lactating females, BC was significantly lower in 2021 relative to other years **(Figure 6).** For non-lactating adults, BC was significantly lower in 2021 relative to 2019, 2020 and 2022. These results likely reflect variability in environmental conditions and its impact on prey availability, and suggest that foraging conditions for whales were comparatively poor in 2021.

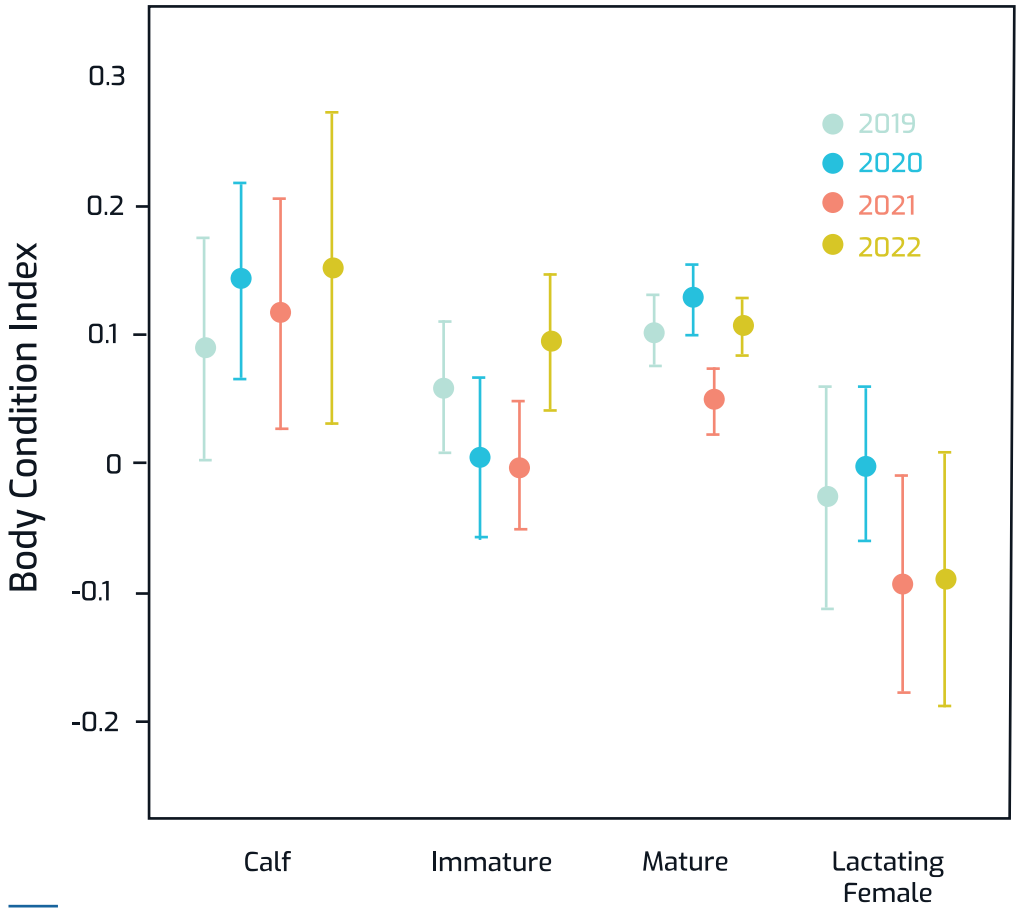


Figure 6.
Late season (September) Body Condition Index (BCI) estimates for calves, immature, mature, and lactating female humpback whales in each year from 2019-2022. A positive BCI indicates that an individual was in relatively better condition than an average individual of the same body length, whereas a negative BCI indicates the individual was in relatively poor condition.

An AWF researcher controls an Unoccupied Aerial System (drone) to capture video of whales in Sitka Sound.

Tissue Sampling

GIVING A WHALE A MEDICAL EXAM

By collecting a small piece of a whale's skin and blubber via a biopsy sample, we can learn about hormone concentrations, diet, DNA, body condition, and much more.

Since 2019, we have been collecting skin and blubber tissue samples to analyze reproductive and stress hormone concentrations among Alaska's humpback whales with our partners at University of Alaska Fairbanks (Atkinson Lab) and University of Hawaii at Manoa (West Lab).

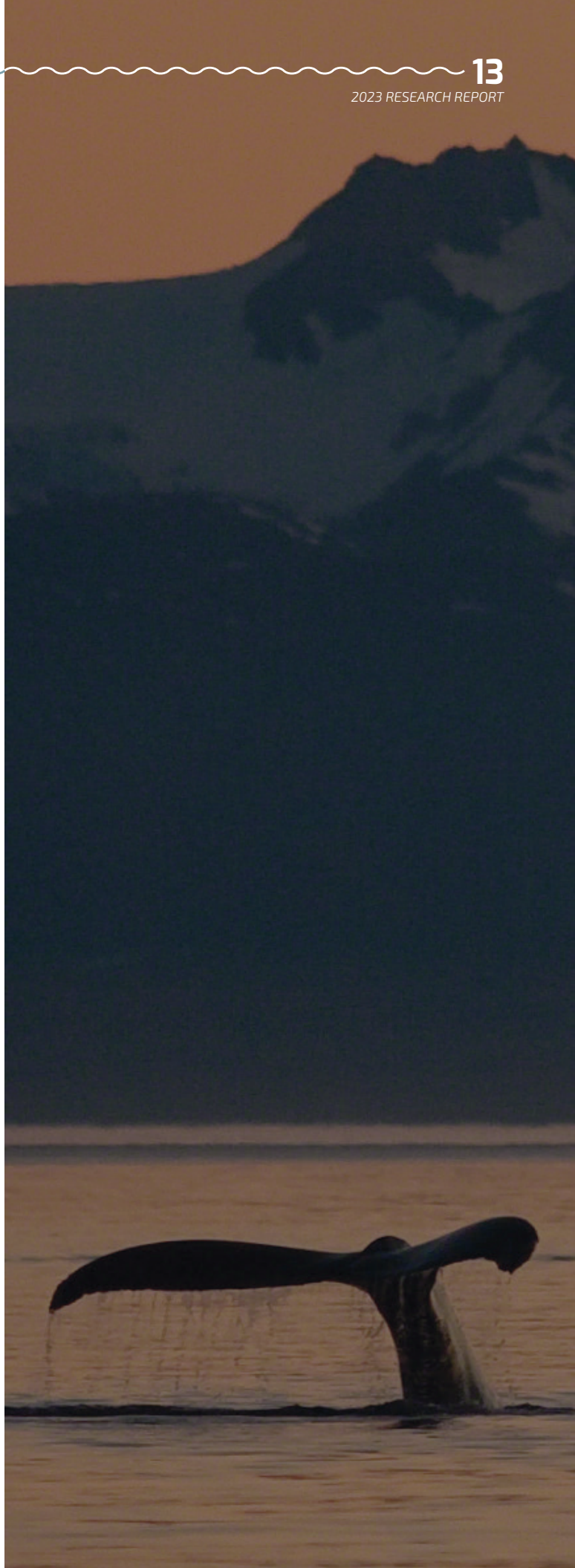
Reproductive state, which can be revealed through hormone assays, is a key indicator of the health of a population and biological parameters needed to calculate rates of population growth are onset of sexual maturity, annual pregnancy rate, and offspring sex ratio (Atkinson & Yoshioka, 2007; Atkinson et al. 2019; Zerbini et al. 2010). Chronic stress negatively affects populations through reduced immune function (Marketon and Glaser, 2007) and compromised reproduction (Atkinson et al. 2015; Sheriff et al. 2009) and is associated with long-term declines in population abundance (Fefferman and Romero, 2013). Elevated concentrations of glucocorticoids (i.e., cortisol and corticosterone) are reliable indicators of physiological stress in mammals (Mingramm et al. 2020).

This year, we conducted a preliminary analysis of 61 biopsy samples collected in the previous year as part of a North Pacific Research Board-funded project and in anticipation of presenting our results at the upcoming Alaska Marine Science Symposium in Anchorage

AWF field crew processing biopsy samples late into the evening.

(January 2024). Our principal objective was to determine if pregnancy predictions made using progesterone concentrations and drone-derived body contour measurements aligned. All sampled individuals were adults, except two (1 subadult, 1 unknown), which we identified via photogrammetric estimates of body length and length of sighting history. Of those individuals, 18 unique females and 40 unique males were genetically determined using skin from the blubber biopsies.

Pregnancy predictions were consistent between photogrammetry and hormone concentrations for three of four whales, which provides support for the combined approach to tracking pregnancy rates. However, that none of these pregnant whales returned with calves in 2023 suggests that the approach could also provide insight into fetal and/or neonatal mortality rates. More generally ongoing, long-term biopsy tissue sampling, alongside our abundance and body condition work, will be a valuable tool to understanding the health status of humpback whales.



Spring and Fall Research in Southeast Alaska

EXPANDING OUR SEASON & SCOPE

Sitka Sound has long been recognized as an important stopover point for whales on either side of their winter migration to their low-latitude breeding grounds. 2023 marked a return for the AWF team to this and other regions in March and October.

Though only a few months separate the whales' ~November/December departure from and subsequent ~March return to Alaska, the difference in their body condition can be striking.

This is because the whales fast while away from Alaska, so they tend to be at their best body condition (i.e., fattest) just prior to leaving in the fall and at their poorest (i.e., skinniest) when they return in March. By measuring the change in body condition between these two extremes, we can estimate the energetic costs the animals incur by migrating and breeding and gain insight into how changes in ocean productivity will impact these behaviors.

Since 2018, we have been traveling to Southeast Alaska in November and March to collect humpback body condition data. This was interrupted by the Covid-19 pandemic between Fall 2020 and Fall 2022; however, this year we were able to resume sampling. Between March 23rd and April 6th, 2023, we collected body condition measures from 55 individual whales in Sitka Sound. As well, we traveled to another area known for its late-season aggregation of whales - Frederick Sound, Stephens Passage, and Seymour Canal - between October 21-31. This latter voyage was supported by the Alaska Endeavor, 501(c)(3) non-profit that provides a research vessel (RV Endeavour) as a platform for research and education trips in Alaska.

During the fall expedition, we collected ~175 body condition images of late season whales, most of which appeared healthy. As well, we resighted 'Old Timer", a well known whale first observed in 1972 making this the longest sighting history for any whale on the planet. As with the rest of our 2023 BC data, processing is still underway. However, we are encouraged by the large volume of data we were able to collect and the support we received from our research partners. As a result, we are now committed to resume full sampling in both March and October in 2024.

NEW RESEARCH INITIATIVE – SPRING GRAY WHALES IN SITKA SOUND

Over the past several years, gray whales appear to have increased in numbers in Sitka Sound from late March through early May. Anecdotal reports from colleagues, commercial fishers, and local whale watching operators have suggested that as many as 150 individuals now aggregate there in early spring. The close spatial and temporal overlap between gray whales and the spring herring spawn in Sitka Sound has raised concerns that whales are feeding on newly-hatched herring larvae. If so, they could substantially impact this culturally, ecologically, and commercially important fish stock.

In Spring 2023, AWF partnered with Dr. Lauren Wild (University of Alaska Southeast) to conduct a pilot study to examine the feasibility of launching a full project addressing gray whale occurrence in Sitka Sound. For one week in early April, we conducted photo-identification, behavioral and drone-based body condition surveys. At the time, we encountered six gray whales, which were located in an exposed area and therefore difficult to sample. Water turbidity was such that gray whales were barely visible beneath the surface, which inhibited aerial photogrammetric measurements. However, on April 2nd conditions improved enough to permit drone-based behavioral observations of five whales. Notably, we observed no obvious signs of feeding. Instead, the whales appeared highly tactile with each other, rolling and splashing at the surface, and frequently approached our research vessel. On one occasion, the genitals of one whale (a male) were clearly visible, though it appears that both sexes were present. Although it is likely that gray whales are feeding in the area, these observations suggest that there is a social component to their presence as well.

We collected suitable body condition images from three of the five whales **(Figure 7)**; data analyses are underway. Dr. Wild continued to monitor the whales through May and reported a substantial increase in gray whale numbers towards the end of April. By mid-May, most animals had left the Sound. During the latter part of their residency in the sound, the whales tended to aggregate in more protected waters and were therefore easier to approach for photo-identification and drone surveys. Therefore, despite less-than-ideal water conditions, it seems likely that a future, more sustained effort that captures the animals at both ends of their ~1.5 month residency will be feasible.

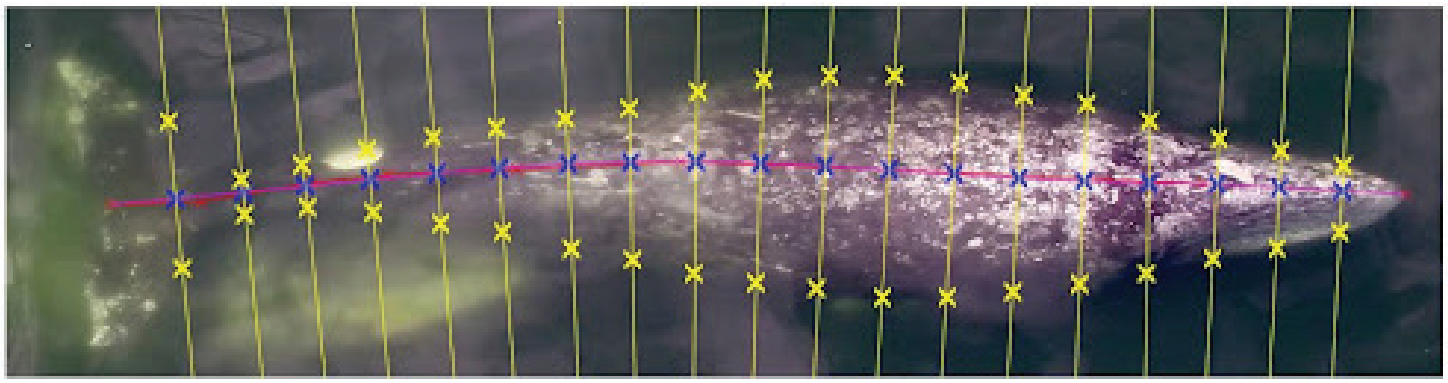


Figure 7.
A drone image of a gray whale in Sitka Sound used to estimate the animal's length and width at 5% intervals along its body.

Spotlight: Large Whale Stranding & Disentanglement Response

AWF, together with NOAA's National Marine Fisheries Service and the US Coast Guard, is part of the Alaska Marine Mammal Stranding Network.

This summer, AWF participated in stranding and disentanglement efforts on multiple missions. In July, our team responded to a report of a well-known whale, Manu, entangled in fishing gear near Juneau. Upon finding Manu, we helped assess the nature and severity of his entanglement, noting that he had crab pot gear laced through his mouth and trailing back beyond his flukes. We were unable to approach close enough to begin removing lines, but helped affix satellite telemetry gear that allowed us to relocate him and monitor his health status once he left the area. Over the ensuing weeks, Manu traveled ~ 700 nautical miles spanning multiple responder districts until, in late July, the erratic satellite pings suddenly stabilized, revealing the tag was no longer affixed to the animal. Shortly thereafter, a sport fisher found the gear floating in Frederick Sound, but there was no sign of Manu. Nearly three months passed with no further sightings raising concerns that he did not survive the ordeal. However, in late October, while conducting fall whale health surveys in Seymour Canal – not far from where we received Manu's last location – our team found him feeding among a large aggregation of whales. And he was looking healthy (i.e., fat!) with no obvious signs of trauma.

In September, three members of our field team assisted in a partial necropsy of a recently beached humpback whale in South Hoonah Sound / Peril Strait. This effort was coordinated by Sadie Wright, NOAA's Alaska Regional Large Whale Entanglement and Oil Spill Response Coordinator, and led on the ground by Dr. Lauren Wild (University of Alaska Southeast). The team collected skin, blubber, eye and baleen samples for a broad health analysis. They found no markings to indicate a clear cause of death; however, the whale's dorsal side, where ship strike trauma would be most evident, was not visible. Sadly, a photo-identification image of the whale's fluke was matched to a well-known and well-loved male whale, Epimeletic (SEAK 0562). The first record of Epimeletic we have in our database comes from Fred Sharpe's research in 1995, but he was encountered by other researchers decades earlier making him one of the older whales in the region.

In October, AWF also assisted the National Park Service in the successful rescue of a young humpback near Glacier Bay, Alaska. The whale was severely entangled with heavy gauge line and partially anchored to a 300-pound crab pot. Using a 25-foot Kevlar pole affixed with a "hook knife", and throwing grapples with cutting blades, the response team made strategic cuts to the lines, allowing the animal to swim away with most of the gear left behind. National Park Service staff were able to match photos of the entangled whale's fluke pattern to a known individual, SEAK-5490, a young whale first documented by AWF in 2021.

As the sun sets on another season, AWF extends our appreciation to our research team & 2023 summer interns for their hard work in the field.

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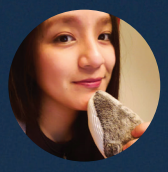

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