INTRODUCTION

The United States Fish and Wildlife Service (USFWS) Recovery Plan for the western snowy plover lists 1.0 chicks fledged per male as a key recovery metric that each recovery unit (RU) must maintain for five years prior to delisting (USFWS 2007). Consequently, researchers in each RU attempt to calculate and report their chicks fledged per male numbers each year. However, in recent years, plover biologists have begun questioning the quality of chicks fledged per male as a statistic. Some longtime researchers, have shifted away from calculating chicks fledged per male and begun using a different metric, breeding efficiency (Colwell et al. 2018). This value is easier to calculate and reduces the amount of uncertainty associated with the necessary variables. However, other researchers argue that chicks fledged per male is a more accurate reflection of snowy plover productivity, despite its issues. The Snowy Plover Recovery Lead Biologist for USFWS, Micah Ashford (RU2), has shown interest in breeding efficiency and suggested that all RUs calculate both their breeding efficiency and chicks fledged per male for the 2025 season.

This is an evolving debate that should eventually result in a standardized methodology across all RUs for the most accurate and precise snowy plover productivity estimate. However, as of the 2025 season, different researchers use a wide variety of methods to calculate chicks fledged per male and breeding efficiency. Therefore, SFBBO has decided to calculate these metrics using several different methods in an effort to make our data more comparable, and demonstrate how differences in methodology change the outcome of the calculation.

CHICKS FLEDGED PER MALE

This is still the standard productivity estimate, but has a low degree of accuracy because researchers must estimate both the number of fledges and the number of males in their system. Counting males is particularly challenging because it can be difficult to tell males and females apart in the field and the number of adults fluctuates considerably throughout the season as migrants come and go. In addition, depending on how one calculates their number of males, the way they calculate their number of fledges must change to be consistent with the male count. Different RUs use different methods to calculate chicks fledged per male. We tried three of the most popular in our calculations.

METHOD 1: NUMBER OF MALES IN THE BANDED SAMPLE

This is how SFBBO calculated their chicks fledged per male in the past. It assumes that the banded sample is a proxy for the entire RU3 population. To calculate the number of males, simply count the number of broods banded. Reduce the total by one for every banded male that is associated with multiple nests. Do not remove chicks banded from undetected nests.

The main issue with this method is that it is nearly impossible to tell if an unbanded male is associated with multiple nests. Even though SFBBO has been banding since 2008, over half of the males associated with nests banded in 2025 were unbanded. This leaves a lot of room for re-nesting males to never be identified.

In 2025, SFBBO banded 69 nests, each with an attendant male. Of those 69 males, 39 were unbanded (57%) and the color-band status of one male was unknown. Of the 29 banded males (42%), all band combinations recorded were unique, meaning that no banded males were associated with multiple nests. Therefore, the number of males using this method is 69.

To calculate the number of fledges for this method, simply count the confirmed fledges from the banded sample. As of February 9, 2026, SFBBO has confirmed that 47 banded chicks have fledged. Therefore, our number of chicks fledged per male is 47 divided by 69, which equals 0.68, as shown in Table 1.

Table 1: Snowy Plover Chicks Fledged per Male

Method	Banded Chicks	Banded Fledges	Fledge Rate (Banded Fledges ÷ Banded Chicks)	Eggs Hatched	Estimated Number of Fledges (Fledge Rate × Eggs Hatched)	Number of Males	Chicks Fledged per Male (Number of Fledges ÷ Number of Males)
1	N/A	47	N/A	N/A	N/A	69	0.68
2	169	47	27.81%	769	214	183	1.17
3	169	47	27.81%	769	214	186	1.15

METHOD 2: BREEDING WINDOW COUNT

The USFWS snowy plover breeding window survey is a convenient data point for counting the number of adults present in a population because it is standardized across the range and every RU has data for it, even if they do not band. Although SFBBO biologists do their best to differentiate males and females from each other during the window survey, it is not always possible to determine the sex of each bird. Therefore for this calculation we decided to consider the total number of adults counted and then multiply that by 0.53, which percentage of males documented in the western snowy plover population in Monterey Bay (Stenzel et al. 2011). During the 2025 breeding window survey, we counted 345 adult plovers at our sites in the South Bay. Multiplying 345 by 0.53 gives us 183 males.

Because this method attempts to estimate the entire population of males, this means we need to estimate the entire population of fledges as well. This is done by multiplying the apparent fledge rate by the estimated total number of eggs hatched in the season (obtained by adding the number of hatched eggs from monitored nests + the number of chicks from nests detected as broods). Calculating the number of fledges using this method involves making two assumptions about nests detected as broods: 1) that we have a 100% detection rate of these nests, and 2) that chicks from these nests are just as likely to fledge as chicks from monitored nests.

Including chicks from nests found as broods, SFBBO estimates that 769 eggs hatched in the South Bay in 2025. As mentioned above, 47 chicks fledged out of 169 banded in 2025, giving an apparent fledge rate of 28%. By multiplying 769 by 0.28, we estimate that the South Bay produced 214 fledges in total. Therefore our chicks fledged per male is 214 fledges divided by 183 males, or 1.17, as shown in Table 1.

Issues with this method include uncertainty in both the male count and the fledge count. First, USFWS chooses the week of the window survey randomly each year. There is no guarantee that the window survey will be the most representative count of the RU for the entire season. Second, estimating the number of fledges from nests found as broods is suspect. We are forced to assume that we have a 100% detection rate of these nests, but we likely do not. Furthermore, chicks from undetected broods may have a higher fledge rate than chicks from monitored nests because they have already survived sometimes multiple weeks before they are detected. For these reasons, SFBBO assumes this is the method with the lowest accuracy.

METHOD 3: MAXIMUM CONCURRENT ACTIVE NESTS PLUS BROODS

This method, adopted from RU6, is similar to Method 2, but attempts to capture the maximum number of breeding males across the entire season, not just during the week of the breeding window survey. SFBBO surveys each nesting site once per week. By combining weekly data from all sites, we can calculate the total number of active nests plus the total number of broods observed for each week of the nesting season across the entire South Bay. The highest of these weekly totals is the number of males used. This assumes that males tending nests are unique from males tending broods, and that the number of males doing neither is negligible.

During the week of June 22, 2025, we recorded 130 active nests and 56 broods for a total of 186. This was the highest total throughout the season, so the number of males used is 186. We will

use the same fledge estimate from Method 2 (214 fledges). Dividing 214 by 186 results in 1.15 chicks fledged per male, as shown in Table 1.

It is encouraging that the number of males calculated using this method is so similar to the number of males calculated in Method 2. However, we prefer this method of counting males since it is more directly tied to breeding activity and also accounts for variation week to week across the season.

Again, because this method this method attempts to estimate the entire population of males, we use the same fledge estimate from Method 2, which introduces the same potential inaccuracies with fledge estimates.

BREEDING EFFICIENCY

Instead of trying to create a ratio of offspring to adults, breeding efficiency (BE) seeks to measure how much effort the adults are spending to produce offspring successfully. It is calculated by dividing the total number of fledges by the total number of eggs laid, or in other words, it is equal to chicks fledged per egg.

To calculate this, we removed some data from our sample to try to standardize the variables as much as possible. First, we removed nests found as broods from both the fledge count and the egg count since we do not know how many eggs were laid in those nests. We also removed any monitored nests with an unknown fate since we do not know whether those eggs hatched or not.

In 2025, we banded 165 chicks from monitored nests, 46 of which fledged. This still results in a fledge rate of 28%. Six hundred and six chicks hatched from monitored nests. Multiplying 606 by 0.28 results in 169 total fledges. The total number of eggs laid in monitored nests of known fate was 995. Dividing 169 by 995 gives us a BE of 0.17, as shown in Table 2.

Research from RU2 has shown a positive correlation between BE and chicks fledged per male, and it is suggested that a BE of 0.20 is roughly equivalent to 1.0 chicks fledged per male (Colwell et al. 2018). Though our BE is blow that benchmark, according to other researchers who have begun using BE, 0.17 shows acceptable productivity for snowy plovers in the South Bay, and numbers above 0.15 do not indicate a cause for concern (David Lauten, *pers. comm*.).

Table 2: Snowy Plover Breeding Efficiency. Numbers used in calculations are from monitored nests of known fate.

Geographic Area	**Banded Chicks**	**Banded Fledges**	**Fledge Rate**	**Eggs Laid**	**Eggs Hatched**	**Estimated Fledges (Fledge Rate × Number of Eggs Hatched**	**Breeding Efficiency (Number of Fledges ÷ Eggs Laid)**
Eastern	112	39	34.82%	569	381	132.67	0.23
Southern	21	3	14.29%	202	108	15.43	0.08
Western	26	2	7.69%	224	117	9.00	0.04
South Bay	***165***	***46***	***27.88%***	***995***	***606***	***168.95***	***0.17***

BREEDING EFFICIENCY BY REGION

Another benefit of breeding efficiency is that we can localize it to different regions of the South Bay, which provides more information about how different areas are performing in comparison to each other. However, since we only banded 27% of the chicks hatched from all monitored nests in 2025, we needed to ensure that each sub-area we considered still had an adequate sample size of banded chicks. Thus, we split the South Bay into three large regions: eastern, southern, and western. The eastern region is the largest and consists of the Hayward Shoreline, ELER, Coyote Hills, and Dumbarton complexes. The southern region consists of the Warm Springs, Alviso, and Mountain View complexes. The western region consists of the Ravenswood and Redwood City complexes. The average distance between complexes within a region is approximately 1.6 kilometers. The average distance between regions is approximately 7.3 kilometers. Delineating the regions this way gives us geographically distinct hubs of plover breeding activity while still providing a large sample size of banded chicks in each region. The breeding efficiency calculations for each region are as follows.

Eastern Region

In the eastern region, we banded 112 chicks from monitored nests, 39 of which fledged. This results in a fledge rate of 35%. Three hundred and eighty-one chicks hatched from monitored nests. Multiplying 381 by 0.35 results in 133 estimated fledges. The total number of eggs laid in monitored nests with a known fate was 569. Dividing 133 by 569 gives a BE of 0.23, as shown in Table 2.

Southern Region

In the southern region, we banded 21 chicks from monitored nests, three of which fledged. This results in a fledge rate of 14%. One hundred and eight chicks hatched from monitored nests. Multiplying 108 by 0.14 results in 15 estimated fledges. The total number of eggs laid in monitored nests with a known fate was 202. Dividing 15 by 202 gives a BE of 0.08, as shown in Table 2.

Western Region

In the western region, we banded 26 chicks from monitored nests, two of which fledged. This results in a fledge rate of 8%. One hundred and seventeen chicks hatched from monitored nests. Multiplying 117 by 0.08 results in nine estimated fledges. The total number of eggs laid in monitored nests with a known fate was 224. Dividing nine by 224 gives a BE of 0.04, as shown in Table 2.

REFERENCES

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