Nocturnal Spotlight Surveys to Estimate Population Size and Trends of *Synthliboramphus* Murrelet Breeding Colonies

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Abstract

In 2001, we developed a nocturnal spotlight survey technique to count Scripps's Murrelets (*Synthliboramphus scrippsi*; SCMU) attending at-sea congregations in near shore waters adjacent to breeding areas at Anacapa Island, California, USA. Spotlight surveys offered a useful alternative to nest monitoring for assessing SCMU population trends and the only method for estimating breeding population size at Anacapa where most breeding occurs in inaccessible habitats. Spotlight surveys and nest monitoring yielded similar regression trends and rates of population increase 12 years after the eradication of rats. By 2015, spotlight surveys had been used to estimate population size at all known murrelet colonies in California and western Baja California, Mexico. To convert survey counts to population estimates, we developed a correction factor at Santa Barbara Island, California which quantified the relationship between the number of SCMU in congregations and the number of nests on the adjacent shoreline. Studies at Birojima, Japan in 2011-2012 confirmed the utility of spotlight surveys for monitoring population trends of Japanese Murrelets (*S. wumizusume*; JAMU) with regression analyses. However, the correction factor used to estimate population size of SCMU colonies did not appear to be valid for JAMU. Calculation of a correction factor specifically for JAMU was not possible at Birojima due to the largely inaccessible breeding habitats and many nests concealed in deep crevices. To estimate population size at Birojima, we surveyed 5 radial transects in 2012 to estimate mean density and extrapolated this density over the entire congregation area which resulted in 2890 murrelets. This estimate was considered similar to the 3,000 total murrelets estimated in 1993-1994 based on telescope counts of murrelets gathering around the island at dusk. The total number of JAMU in the congregation was adjusted to account for subadults in the congregation and breeding adults on the island, yielding a minimum of 1,705 breeding birds at Birojima in 2012. Spotlight survey efforts are needed at other JAMU breeding islands to better assess population trends, estimate population size, and determine the feasibility of calculating a correction factor for JAMU.

Key words: *Synthliboramphus* murrelets, at-sea congregation, population monitoring, Birojima, spotlight surveys

Introduction

Anyone who has worked with *Synthliboramphus* murrelets, knows all too well the difficulties of studying these species. The main challenges stem from the rugged and often remote islands where these small seabirds breed (Figure 1). When working at islands like Teuri in Hokkaido, Anacapa Island, California, and Birojima, even basic questions such as "Where are they breeding?", "How many are breeding there?", and "Are the populations increasing or decreasing?" can be very difficult to answer. For the last 23 years, we have been attempting to answer some of these questions. We realized very early that alternatives to traditional nest monitoring would be needed because murrelet nests are hidden in rocky crevices or under dense vegetation in breeding habitats that can be very difficult, if not impossible, to search. This is especially true at islands where mammalian predators, such as foxes, rats, and cats are present. However, one conspicuous feature of murrelet social behavior that makes it easier to find and estimate the size of colonies is their tendency to congregate nightly at sea adjacent to nesting areas during the breeding season. In this paper, we review spotlight survey techniques used to determine the size and population trends of murrelet colonies.

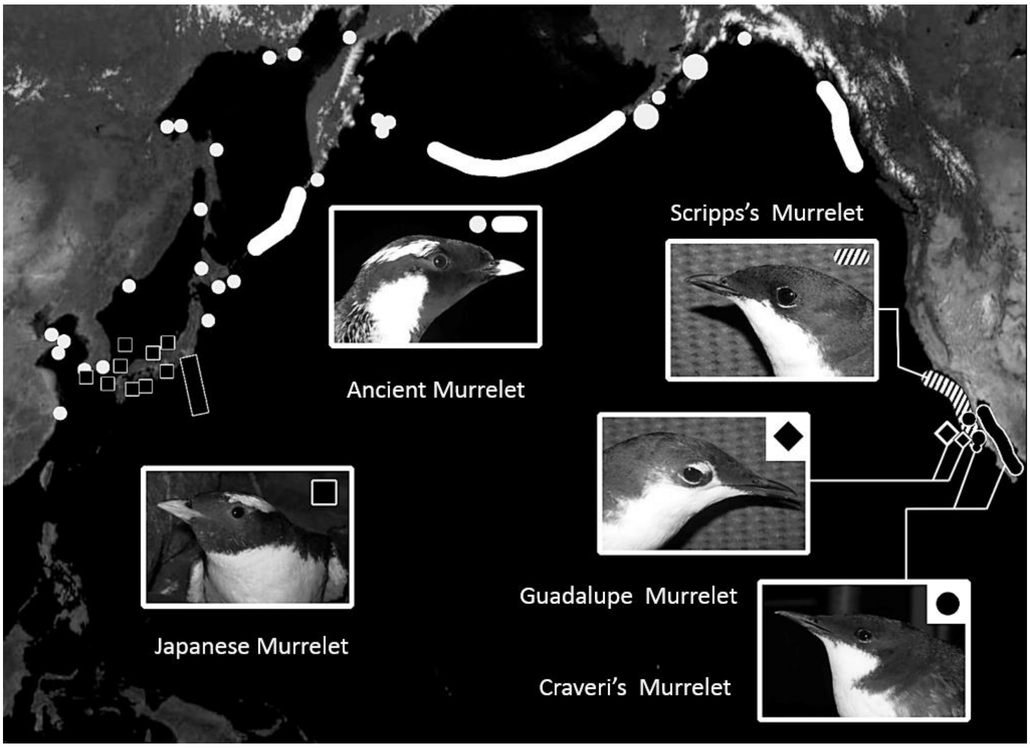

Figure 1. Breeding range of *Synthliboramphus* murrelets in the Pacific Ocean.

Review of Spotlight Survey Techniques

In 2000, we developed an at-sea survey technique using small boats and spotlights to count murrelets congregating on the water just off nesting areas at night (Whitworth and Carter 2014). We presumed the number of murrelets in these congregations could serve as an index of population size and be used to monitor trends. The spotlight survey technique was developed at Anacapa Island, California to assess recovery of Scripps's Murrelets after rats were eradicated in 2002. We conducted baseline spotlight surveys at Anacapa in 2001-2003 then went back again in 2014 to see if spotlight counts had increased. In fact, mean counts on round-island spotlight surveys increased almost 4-fold from 2003 to 2014. We also compared spotlight survey counts with the numbers of nests found during nest monitoring in 2001-2010 and 2014 (Figure 2). Time series regression detected significant

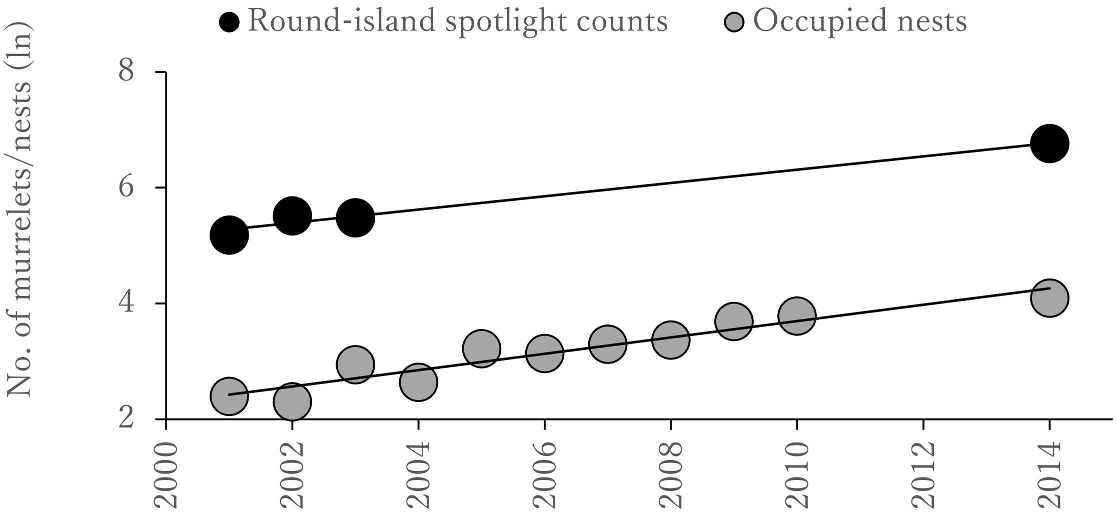

Figure 2. Regression of log-transformed nest counts and annual mean round-island spotlight counts of Scripps's Murrelets at Anacapa Island, California in 2001–2014.

increases in the number of occupied nests, which increased 15.1% each year, and mean round-island spotlight counts, which increased 12.2% (Whitworth and Carter 2017).

The usefulness of spotlight surveys for assessing population trends was also demonstrated at San Clemente Island, California which hosts one of the smallest Scripps's Murrelet colonies in the world. Only 6 murrelet nests have been found at Seal Cove in the last 5 years, probably because most murrelets nest in steep inaccessible cliffs to avoid predation by foxes and cats. We performed power analyses on spotlight survey data from 2012-2016 to determine the probability of detecting population trends with spotlight surveys (Whitworth et al., in press). As expected, more intensive surveys were better for detecting trends; a 20-year program with 18 surveys/year conducted annually could detect, with 80% probability, population changes as low as 1.5% per year (Figure 3).

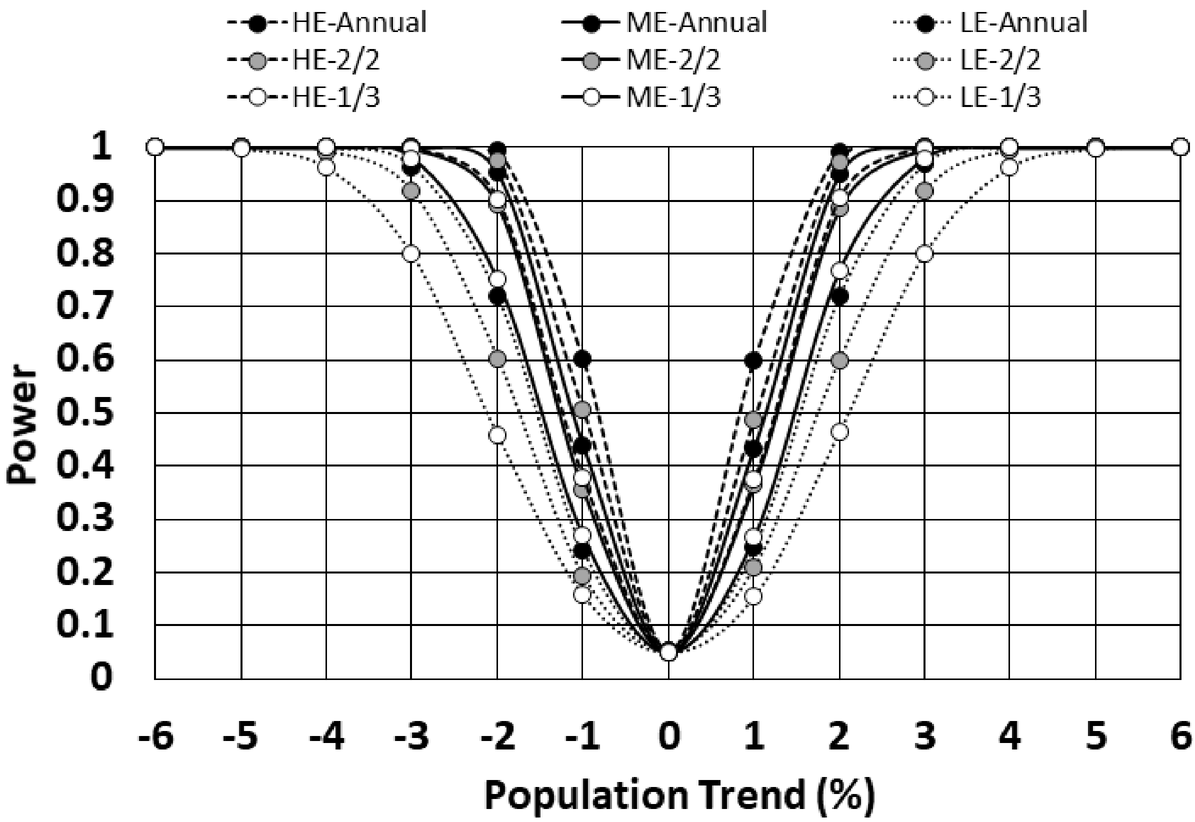

Figure 3. Power to estimate Scripps's Murrelet population trends over 20 years using spotlight surveys at San Clemente Island, California. Charts shows power for high-effort (HE = 18 surveys/year), medium-effort (ME = 12 surveys/year), and low-effort (LE = 6 surveys/year) monitoring plans conducted annually, 2 years every 4 years (2/2), and every 4th year (1/3).

Spotlight survey monitoring has also been conducted at Teuri Island, Hokkaido, Gugul-do, South Korea, and Catalina Island, California. Thus, this technique has become an important new monitoring tool for assessing murrelet population trends. However, reliably determining the number of murrelets at a colony has posed a much more daunting task. Simply visiting an island and conducting a nest census is usually not an option, so we are currently examining methods using spotlight counts to determine population size.

Santa Barbara Island (SBI), California is unique in the Scripps's Murrelet range because many nests are found on in accessible habitats on gentle slopes and almost all nests are accessible to researchers on foot or by boat. This is the only murrelet breeding area in North America where we could reasonably estimate the relationship between the number of nests in a defined area and the number of birds congregating in the adjacent nearshore waters. We conducted concurrent spotlight surveys and nest searches at SBI and used this data to calculate a very simple correction factor that converted spotlight counts into an estimate of the number of nests (D. Whitworth, unpublished data); CF = N/M where N = number of nests and M = number of murrelets. Nest searches on SBI yielded 107 occupied nests (N) and the mean spotlight survey count (M) was 67 [± 14 SE] murrelets; 95% CI =

37–97. These values yielded a correction factor of 1.60 (95% CI = 1.10-2.89) nests per murrelet observed. We used this correction factor to estimate population size for most murrelet breeding islands on the Pacific coast of southern California and Baja California. However, more studies are needed, preferably over more than 1 year to better assess inter-annual variation in nest count and spotlight survey data.

In 2011, we visited Birojima in Miyazaki-ken, Kyushu (Figure 4) with Kuniko Otsuki and other researchers from Japan to conduct the first spotlight surveys at a Japanese Murrelet colony. Our surveys were originally scheduled for early April but were delayed until late April by the tragic earthquake and tsunami that struck Japan in March 2011. By the time we began surveys, it was clear that many nests had already hatched and a large proportion of the Birojima population had already left the island. We concentrated our spotlight survey efforts in 2011 on round-island surveys, first to determine whether Japanese Murrelets gathered around Birojima at night, and if so, to assess whether the Scripps's Murrelet correction factor was applicable for estimating the size of the colony.

Figure 4. A view of Birojima, Miyazaki-ken, Japan which hosts the largest colony of Japanese Murrelets in the world.

We found Japanese Murrelets did congregate near Birojima at night, and like Scripps's Murrelets, spotlight counts varied considerably within and between nights. Our round-island counts ranged from 207 to 536 murrelets (Whitworth et al., in review). Using the SBI correction factor with the mean round-island survey count (337 murrelets) yielded just 539 (range = 370-974) nests or breeding pairs. At the time, we considered this a gross underestimate of the actual population size caused by the late timing of surveys in 2011.

We continued with round-island surveys in 2012, but counts were even lower than in 2011, ranging from just 33 to 140 murrelets during the peak incubation period in early April. Thus, differences in congregation attendance behavior appeared to invalidate use of the SBI correction factor for Japanese Murrelets. Unfortunately, calculation of a correction factor specifically for Japanese Murrelets was not possible at Birojima due to the large amount of inaccessible breeding habitat and many nests that were hidden in deep crevices.

After the very low round-island survey counts on the 1st night of surveys in 2012, we surveyed 5 radial transects to examine whether Japanese Murrelets might sometimes congregate farther from shore than Scripps's Murrelets. In fact, we found most Japanese Murrelets congregating about 1 km from shore in 2012. We again noted much variation in congregation attendance within and among the radial transects. Totals for the 5 radial transects combined ranged from 140 to 550 murrelets. As an alternative to the correction factor, we calculated murrelet density during radial spotlight surveys and used this value to estimate the total number of birds in the at-sea congregation. Using a 200-m strip transect over the total 5.3 km transect length, the maximum count yielded an overall density of 516 murrelets km^{-2}. The congregation area (5.6 km^2) was determined with a polygon created by connecting the distal murrelet observation waypoints on all 5 radials during the maximum count on 7 April 2012. Extrapolating the transect density over the entire congregation area yielded a total of 2,890 murrelets.

At-sea captures of murrelets in the congregation on 6 April indicated that 59% were breeding adults based on the presence of brood patches. Applying this proportion to the total of 2,890 murrelets in the at-sea congregation yielded 1,705 breeding birds, which we considered the minimum size of the breeding population at Birojima in 2012. This estimate was similar to a previous estimate of 3,000 total murrelets from dusk telescope counts of birds congregating at sea around Birojima conducted by Koji Ono, John Fries, and Yutaka Nakamura in 1993-1994.

Thus, despite heavy predation by crows, there is no evidence for a major decline in the murrelet population at Birojima since 1994. However, larger survey samples are needed to establish a better baseline for measuring future population trends.

Literature Cited

Whitworth, D. L. & H. R. Carter. 2014. Nocturnal spotlight surveys for monitoring Scripps's Murrelets in at-sea congregations at Anacapa Island, California. Monographs of the Western North American Naturalist 7:306–320.

Whitworth, D. L. & H. R. Carter. 2017. Population trends for Scripps's Murrelet following eradication of Black Rats. Journal of Wildlife Management: in press

Whitworth, D. L., H. R. Carter, M. W. Parker, F. Gress & M. Booker. In press. Long-term monitoring of Scripps's murrelets and Guadalupe murrelets at San Clemente Island, California: evaluation of baseline data in 2012–2016. Monographs of the Western North American Naturalist.

Whitworth D. L., H. R. Carter, Y. Nakamura, M. Takeishi & K. Otsuki. In review. Nocturnal at-sea spotlight surveys of Japanese Murrelets (*Synthliboramphus wumizusume*) at Birojima, Miyazaki-ken, Japan. Journal of the Yamashina Institute of Ornithology.

摘要

2001 年，アメリカ，カリフォルニア州で，私たちは，アナキャパ島の営巣箇所付近の洋上に集合するスクリプスウミスズメ [1](*Synthliboramphus scrippsi*; SCMU)をカウントするため，夜間スポットライトサーベイを開発した．アナキャパ島の殆どの SCMU の営巣箇所は, 調査員のアクセスが困難な場所にある. スポットライトサーベイは, 巣のモニタリングにとって代わり, アナキャパ島の SCMU の個体数動向を評価する有効な手段を提供し, そして, アナキャパ島での繁殖個体数を推定する唯一の有効な方法を提供した．スポットライトサーベイと巣のモニタリングは，ネズミの根絶から 12 年後の個体数の増加について，同様の傾向と割合を示していた．2015 年までに，スポットライトサーベイは，カリフォルニアとメキシコのバハ-カリフォルニアの西部の全てのウミスズメ類の繁殖が知られている島において，個体数の推定のために用いられた．調査で得られた数を個体数の推定に変換するため，サンタバーバラ島（カリフォルニア州）で補正係数を作成した．これは，群れにあつまる SCMU の数と隣接する海岸線の巣の数を関連づけるものである．2011-2011 年の枇榔島での研究では，回帰分析を用いてカンムリウミスズメ(*S. wumizusume*; JAMU)の個体数動向をモニタリングするための，スポットライトサーベイの有用性を確認した．しかしながら，SCMU のコロニーの規模を推定するために使用された補正係数は，JAMU にとって有効性を示さなかった．枇榔島では，アクセスが不可能な営巣地が多く，また，深い岩の隙間に隠れ見えない巣が多いため，JAMU 専用の補正係数の計算は不可能であった．枇榔島の個体数規模を推定するために，2012 年は 5 つの放射状トランセクトを設け調査を行い，平均密度を推定し，この密度を群れが確認された全区域にあてはめ推定したところ，総個体数として 2,890 羽が推定された．これは，1993-1994 年，島からの夕暮れ時のカウント結果(望遠鏡用)をもとに推定した個体数 3,000 羽 に近いものとなった．2012 年の群れ中の JAMU の総個体数を，群れ中の若鳥や，島にいる繁殖鳥も考慮して調整された結果，2012 年の繁殖数は最低でも 1,705 羽であるという結果になった．スポットライトサーベイの取り組みは，個体数動向をより正確に評価するため，個体数規模を推定するため，そして JAMU のための補正係数の算出の可能性を見極めるため，他の JAMU の繁殖地においても，実施が望まれる．

[1] 標準和名は　セグロウミスズメ．もともとは，1 種だったものが遺伝解析の結果，2 種に分かれた．和名は，１つのままであるため，今回は，混乱をさけるため，英名をカタカナで表記した．