Sea Duck Joint Venture
Annual Project Summary
FY2021 (October 1, 2020 – September 30, 2021)

Project Title:
Identifying demographic bottlenecks and habitat use to support the recovery and management of American common eider: a range-wide, full life-cycle telemetry project (SDJV Project #162).

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Project Description:
The target population for this project is the American subspecies of the common eider (*Somateria mollissima dresseri*). The project will address elements of Science Need 1 (Improve understanding of population delineation, migratory connectivity and key habitat use of sea ducks by targeting geographic gaps from previous satellite telemetry studies), Science Need 6 (breeding propensity) and Science Need 11 (evaluation of body condition documented shifts in species distributions). This study will also contribute to future harvest assessments for this population.

Methods — The main component of the study involves the deployment of ~184 PTTs. PTTs will be distributed across entire breeding range of *dresseri* (28 in Maine, 26 in New Brunswick, 35 in Nova Scotia, 40 in Québec, 25 in Newfoundland and 30 in Labrador; Fig. 1). We had planned to deploy PTTs in Maine, and New Brunswick or Nova Scotia in 2021, but Covid-19-related border restrictions prevented crews from working in Atlantic Canada. The 2021 deployments were therefore restricted to Maine and Québec. PTTs were deployed on adult female eiders captured by using over-water mist nests during the last week of April and first week of May near Portland, Maine and Rivière-du-Loup, Québec. Glenn Olsen oversaw the Maine surgeries and Stéphane Lair the implants in Québec. We used Microwave Telemetry's implantable double battery PTTs (https://www.microwavetelemetry.com). The model weighs ~65 g and has a battery life expectancy of ~2025 h. The PTTs were programmed on a duty-cycle of 2 h ON and 18 h off during the breeding season, and 3 h ON and 52 h OFF for the remainder of the year.

We also deployed twenty-three, 25 g solar powered GPS-GSM tags (OrnitTrack 25, https://www.ornitela.com). These tags were attached to the contour feathers on the bird's back using Tesa ® tape and the edges of the tape were glued with thick UV glue to limit the bird's ability to lift the edges of the tape when preening. All GSM tags were deployed in Maine. Only four of the tags were deployed in Québec, because issues with a boat cut the field season short and we prioritized deployment of PTTs over GSMs. We have 19 GSM tags left to deploy in 2022. These are the 3G models and must be deployed in Canada. We tested 3G coverage at potential sites in NS and NB in winter 2021 and coverage was not adequate, hence these tags will have to be deployed in Québec. We have made an initial examination of the location and accelerometer data from the GSM and notes on processing GSMs are found (https://rpubs.com/GillilandSG/811998).

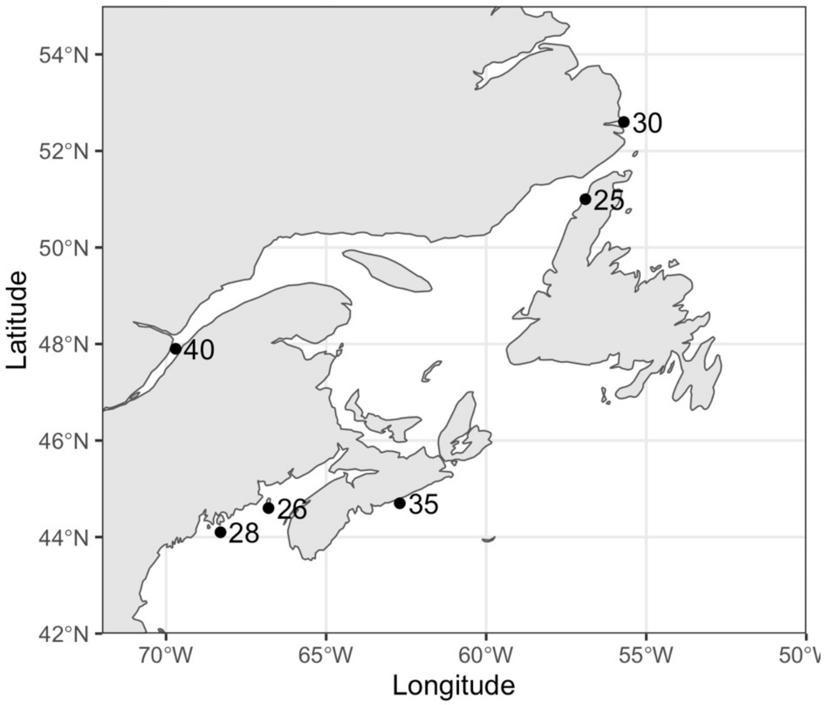

Figure 1. Study area and planned deployments of PTTs on Common Eiders.

Project Objectives:

The primary objectives for this study are to document the current rates of non-breeding and pre-breeding body condition of American common eiders across their breeding range, and to establish a large geo-spatial database from tracking data with which we will examine multiple aspects of the movement ecology of *S. m. dresseri*, but particularly their current habitat use throughout the annual cycle. Specifically, our objectives are:

1. Deploy up to 184 PTTs on adult female common eiders.
2. Develop new methodology to assess the breeding status of common eiders.
3. Estimate relative levels of breeding propensity and body condition across the breeding range of American common eider.
4. Identify the periods in the annual cycle when mortality of adult females occurs.
5. Use telemetry data to identify marine habitat use, assess marine ecosystem changes in eastern North America and identify drivers of altered abundance and habitat use by American common eiders.
6. Identify inshore benthic habitat used by common eiders to inform impact assessment and marine spatial planning processes, as well as coastal and marine protected area planning and establishment.

Preliminary Results:

Captures & Sample Collection – Between 27 April and 7 May we captured 215 Common Eiders around colonies in Québec and Maine (Table 1). Female ages were determined by bursal measurements, adult male ages were based on plumage and sub-adult male using bursal depths (Fig.

2b). Prior to the field season we examined bursal measurements for eiders collected at a colony in New Brunswick in April and early May from 1984 to 1987 (Hicklin unpub. data) and no birds at the colony had a measurable bursa. We were surprised at the number of females captured in Maine with bursal measurements up to 25 mm in length. We are unaware of any studies that report the relationship between age and bursal measurements for Common Eiders. For now, we have created a preliminary age key based on the observed distribution of bursal length from Hicklin's (unpbl. data) collections (Fig. 2a). Age classes were:

1. Bursa = 0 mm, Adult (> 3 years old),
2. Bursa > 0 & ≤ 10 mm, 3year (not quite 3 years old),
3. Bursa > 10 & ≤ 25 mm, 2year (not quite 2 years old), and
4. Bursa > 25 mm, 1year (not quite 1 year old).

The bursas in Hicklin's study were dissected out and the length measured to the nearest mm with a ruler. In Surf Scoters (*Melanitta perspicillata*), bursal depths measured this way were 2 times longer than probed measurements (Gilliland & Savard 2021), and we suspect our probed measurements may overestimate age using Hicklin's data. Figure 3 summarizes the age-structure of the eiders that were captured. As expected, most birds caught around the colonies in Québec were of breeding age; however, 46% of the females captured were ≤ 2 years old. The number of 2year age class females captured was high suggesting production and survival of the Maine 2019 cohort may have been good.

We collected tissue samples for contaminants, genetics, the yolk precursor vitellogenin (VTG), triglycerides, isotopes, and possibly thiamine analyses. The samples are currently stored at facilities at BRI and UQAM. The samples for the VTG and triglyceride analyses from the Québec captures have been sent to Oliver Love at the University of Windsor. The Maine samples are awaiting permitting and will be sent to Windsor when the permitting has been completed. The remainder of the samples will be stored temporally at BRI and UQAM. Once feasible all samples will be moved to BRI for storage over the next couple of years. We will eventually look for a facility to store the samples long-term.

Table 1. Age and sex of Common Eiders caught in Maine and Québec, 28 April to 7 May 2021.

		Study Area	
Sex	Age[1]	Maine	Québec
Female	1year	3	0
	2year	28	1
	3year	3	8
	adult	33	37
	NA	1	0
Male	2year	2	0
	adult	63	36
Totals		133	82

[1] Preliminary estimates of age based on probed bursal measurements.

Table 2. Tissue samples collected from Common Eiders caught in Maine and Québec, 28 April to 7 May 2021.

		Study Area	
Sex	Tissue type	Maine	Québec
Female	Whole Blood	68	46
	Plasma	68	46
	Feathers	60	46
	Skin	29	44
Male	Whole Blood	24	36
	Plasma	18	36
	Feathers	24	36
	Skin	6	35

GSMs – Between 29 April and 4 May we deployed 22 GSMs on female eiders (4 in Québec and 18 in Maine). The attachment methods worked well. The birds retained the tags for an average of about 40 days (39 ± 30.5; range 5 to 140 days), although three of the tags were shed in less than 2 weeks. Interactive maps of the GSM data can be found at: https://rpubs.com/GillilandSG/812109 .

None of the 4 females tagged in Québec initiated nesting; however, twelve of the 18 females tagged in Maine initiated nesting. The mean nest initiation date in Maine was 14 May ± 11 d. The initiation dates appeared to be bi-modal, with two of the females delaying nest initiation until 4 and 7 June. To estimate breeding effort from the birds tagged with GSMs in Maine, we restricted the dataset to tags that were retained for more than 20 days. Breeding effort appeared to be very high as nine of the 11 females initiated nesting (82%, CI: 0.48 - 0.98%). Moreover, eight of the nine females that initiated a nest appeared to complete incubation. The average time from initiation of the nest to departure from the colony for females that incubated was 25 days (± 6.4, n = 8). Two of the females had initiated nesting very late (~ 1 month following deployment) and it is possible we underestimated breeding effort as only one of the two females that did not initiate was tracked for more than 30 days. There was no difference in body mass between the non-breeders and breeders (P=0.95, mean = 2,341g ± 199, n=17) for the Maine birds.

Interestingly, seven of the 12 females from Maine that appeared to make a breeding attempt had bursal lengths between 10 and 25 mm suggesting they were 2-year birds. Of the 2-year birds tagged, the majority attempted breeding (7 of 10; 70%, CI: 35 - 93%) suggesting a high recruitment rate for the 2019 cohort. The rate of breeding for adults was similar (5 of 8; 63%, CI: 25 – 91%).

One of the primary uses of the GSM data was to provide detailed behavior during the pre-breeding and nesting periods which will be used to estimate the probability of detecting a nest initiation event from the PTT data (see below). The GSM data should provide a rich dataset to simulate the duty-cycles of a PTT as we collected ~3,400 locations from 12 females for the week preceding nest initiation, and >3,000 locations from 11 birds during laying and incubation.

PTTs – Between 28 April and 7 May we deployed 68 PTTs on female eiders (40 in Québec and 28 in Maine). As of 21 September 2021 there had been two mortalities (~3%) and the remaining PTTS were active. Interactive maps of the PTT data can be found at: https://rpubs.com/GillilandSG/812086 . We used a 2-season cycle: an intensive cycle of 2 h ON and 18 h OFF during the breeding season, and 3 h ON and 52 h OFF during the rest of the year. We had concerns that the 2 h ON cycle may not be long enough to acquire high quality locations.

ARGOS satellite coverage is poorer near the poles and we expected the quality of locations in Maine to be lower than in Québec. However, performance of the PTTs was excellent, and most locations were of high quality, and better quality of locations were slightly more abundant in Maine (Fig. 4).

We hope to determine breeding status for each PTT tagged female for up to two breeding seasons following deployment. We had not intended to use the first breeding season's data to evaluate breeding status as females were unlikely to breed in the year they are tagged (G. Gilchrist pers. comm.). However, we will use data from the first breeding season to develop methodologies to estimate the probability that a female attempted nesting. One of the concerns is if spatial and temporal resolution of the Argos-based locations are sufficiently fine to detect stationary periods associated with nesting. To address the temporal component, we hope to use the GSM data to simulate the duty-cycle of the PTTs to determine the probability of detecting a female during the cycle of the PTT. The poorer spatial resolution of the ARGOS locations is more problematic to address.

For this report we made a very quick index of breeding effort by digitizing the shorelines of all the eider colonies and counting any ARGOS class 1 and 2 locations that occurred on the colonies. Even this very coarse index of breeding suggests female eiders in Québec spent much more time on the colonies than females in Maine (Fig. 5). We suspect the lower number of high quality locations for the females tagged in Québec may have resulted from spending more time on colonies where heavy vegetative cover interfered with the reception from the PTTs. Interestingly, there was no difference in body mass between the PTT tagged females from Maine and Québec ($P=0.75$, mean = 2213 g ± 234, $n=17$).

We've explored the use of continuous-time state-space models to identify quasi-stationary periods associated with nesting (see Appendix I). We've initiated discussions with Ian Jonsen (Macquarie University) about the use of these models and he's offered to tweak his foieGras package (Jonsen *et al.* 2020) to better resolve nesting behaviour. We also initiated discussions with Franny Buderman (Penn State University) about applying these methods to the PTT data.

Movements – The PTTs have been deployed for about > 4 months and movements of most birds have been highly localized. In Maine, all but 3 of the females remain in the vicinity of the release site. One bird (Female 212566) departed the release area taking an overland flight through Maine to the St. Lawrence Estuary, Québec on 3 June. Another female (212552) moved about 175 km to the northeast and is now just north of Bar Harbor, Maine, and the other female (212546) about 150 km to the northeast and is now just to the west of Acadia National Park in Maine.

In Québec, most of the females have remained in the St. Lawrence Estuary. Areas that have very high use are the shoals of the Marine Park at the mouth of the Saguenay River and Baie de Mille-Vaches just west of Forestville. Three females have migrated, two took the overland over eastern Maine and female 212533 is now near the release site in Maine and the second (212538) is about 25 km northeast of Boston, Massachusetts. The third female took a coastal route around the Gaspé Bay and down the east coast of New Brunswick, crossing the isthmus between New Brunswick and Nova Scotia, and is now in St. Mary's Bay, Nova Scotia.

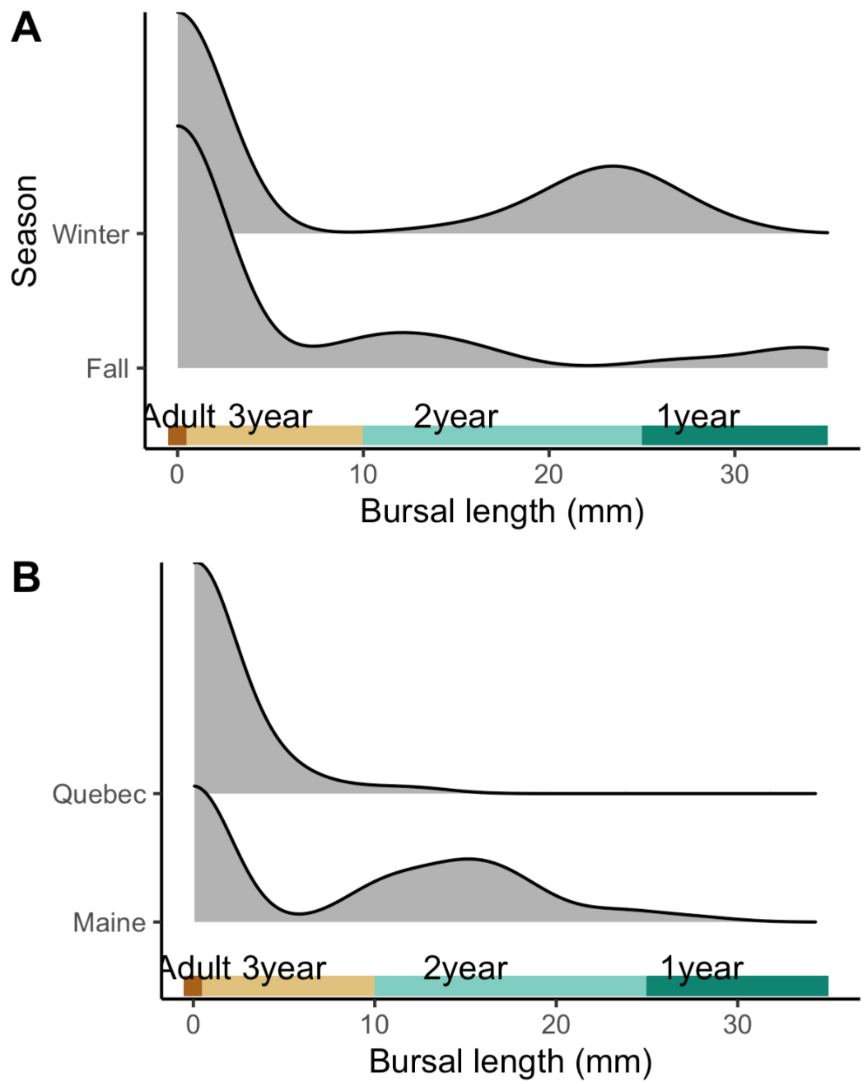

Figure 2. Panel A shows distributions of dissected bursal measurements take from Common Eiders collected in New Brunswick from 1984 to 1987 (n = 143), and Panel B distributions of probed bursal measurements from female Common Eiders captured at arrival to the breeding colonies in Maine and Québec in 2021 (n = 70).

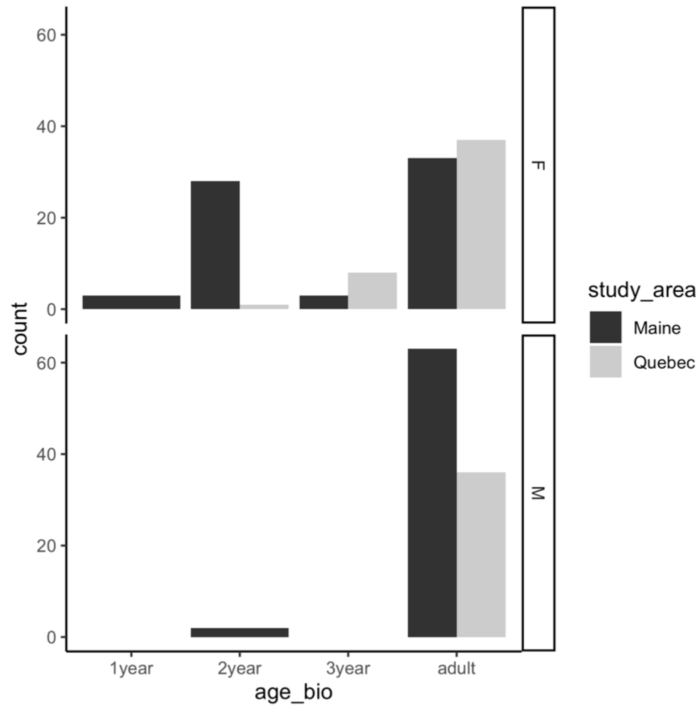

Figure 3. Age structure of Common Eiders captured at colonies in Québec and Maine during the pre-breeding season in 2021 .

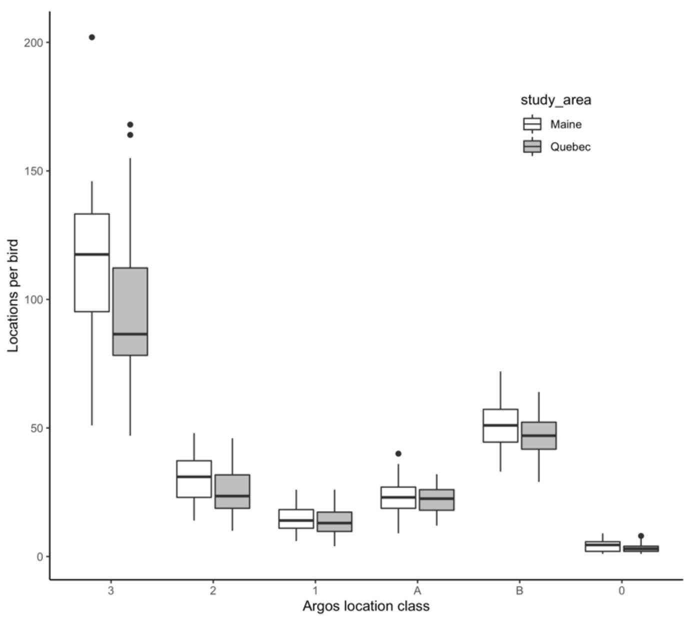

Figure 4. Boxplots of the number locations per PTT by ARGOS location class for Common Eiders tagged in Maine and Québec from May to September 2021.

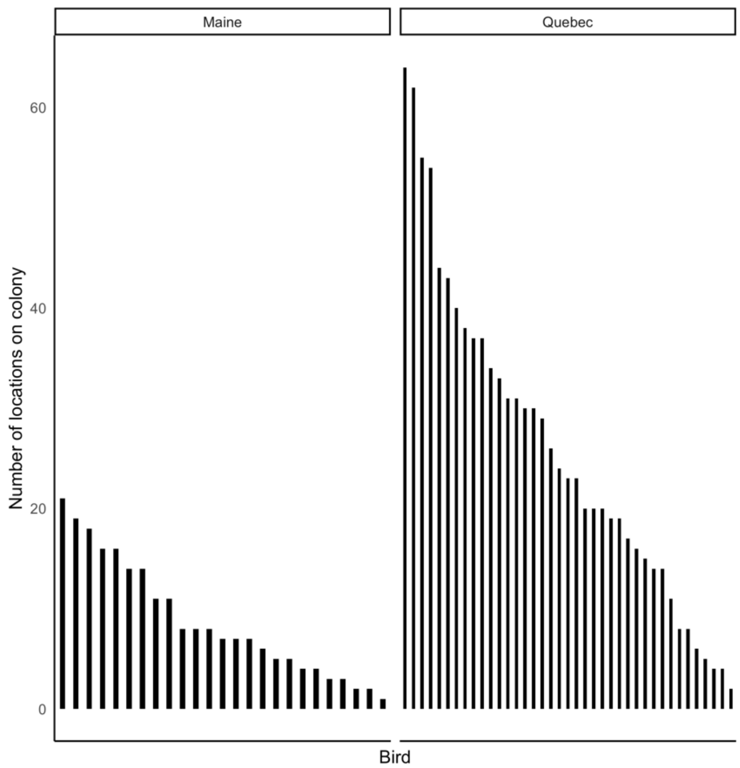

Figure 5. Counts of ARGOS class 1 & 2 locations from PTT tagged female Common Eiders that occurred over eider colonies in Québec and Maine during the nesting season in 2021 .

Project Status:

There were many challenges that had to be overcome to deliver the field program in 2021. The main challenge resulted from Covid-19. Environment and Climate Change Canada staff were unable to conduct field work and border restrictions in Atlantic Canada prevented captures in New Brunswick and Nova Scotia. The lack of ECCC staff and the many Covid-19 related restrictions imposed on working conditions in Canada required hiring additional contractors, separate accommodations and a separate workspace for the surgeries resulting in much higher costs than budgeted for in 2021.

The Québec crew had many additional challenges. A minor mechanical failure of an outboard resulted in a couple of lost days as parts were non-existent due to Covid-19, in the end a new outboard had to be purchased outboard in the middle of the field program. In addition, the main work boat was swamped at the wharf requiring lots of additional work to deal with the boat and equipment. In spite of these setbacks, the crew made an extraordinary effort as they were still able to capture the birds to deploy the remaining PTTs.

We were quite surprised with the number of captures of young females at the colonies in Maine. We are unaware of any published datasets that described the relationship between bursal length and age for Common Eiders. We will contact aviculturists across the continent to search for known age eiders to try and build a dataset that can be used to describe the relationship between age and bursal length. If the results of the pentosidine assays look promising, we also hope to collect tissue samples from known age birds at aviculturists to validate the age curve.

The data streams from the GSMs are rich with information and we would like to expand the GSM component of the study to include units in the Maritimes and Newfoundland and Labrador. Mallory is currently searching for a MSc student that will focus on the GSM data. We have about 15 GSMs from this year that were not deployed. As mentioned above, we may be restricted to deploying these in Québec because the deployment site needs reliable 3G cell coverage. To have reliable communications with the tags in areas with poor cellular coverage we would like to switch to models that have both GSM and UHF radios which would allow data to be downloaded via a UHF base station that would be installed on the colonies. We are currently looking for funds to run the deployment site in Québec in 2022, and funds to purchase additional GSM/UHF units.

As mentioned above we are also looking to source additional funds to support Franny Buderman to do develop methodologies to identify stationary periods associated with nesting using the PTT and GSM data. From our preliminary discussions we feel that measuring the actual location errors for the PTT would be useful for modelling breeding probabilities from the PTT data and we are planning to deploy PTTs on within the colonies at known locations to estimate location errors.

Acknowledgements:
The Québec work would not have been possible without the dedication of the field crew Francis St-Pierre, Manon Sorais, and Sylvain Dorey and the veterinarians Marion Jalenques, Juliette Raulic. Special thanks to Duvetnor (https://duvetnor.com/en/) for opening their facilities early and ensuring the safety protocols imposed by Covid-19 were met. For Maine we would like to thank the dedicated Maine crew consisting of, Dustin Meattey, Bill Hanson, Tim Welch, Chris Persico, Helen Yurek, Logan Route, Brad Allen, and Chris Dwyer. Thank you to the expert veterinary crew of Glenn Olsen, Tori Mezebish, and Tristan Burgess. Finally, we thank Dave Douglas for discussions and guidance on PTT duty-cycles and Sarah Gutowsky for exploring the PTT data.

References:

Jonsen, I.D., Patterson, T.A., Costa, D.P. *et al.* A continuous-time state-space model for rapid quality control of argos locations from animal-borne tags. *Mov Ecol* 8, 31 (2020). https://doi.org/10.1186/s40462-020-00217-7

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Appendix I. Initial results from space-state models using a movement persistence index to detect quasi-stationary periods associated with nesting. Source: S. Gutowsky.