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A Developmental Guide to Aging Saltmarsh Sparrow (*Ammospiza caudacuta*) Nestlings

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The Saltmarsh Sparrow (*Ammospiza caudacuta*) may be the nation's most imperiled bird species that is not listed under the Endangered Species Act. According to the latest status review by the US Fish and Wildlife Service (USFWS 2021)—"While the species still occupies the majority of its historical range, the number of individuals within the breeding range has significantly declined. More than four out of every five Saltmarsh Sparrows have disappeared since 1998—an estimated population decline of 87 percent. The U.S. Fish and Wildlife Service is reviewing the Saltmarsh Sparrow's status and, by the end of September 2023, will make a determination of whether or not the Saltmarsh Sparrow warrants protection under the Endangered Species Act."

Adult Saltmarsh Sparrow at the Jacob's Point study site (photo by Deirdre Robinson).

The Saltmarsh Sparrow (SALS) breeds in salt marshes from Virginia to Maine—and nowhere else on the globe (Greenlaw et al. 2020). Its habitat requirements make it highly vulnerable to the impacts of sea-level rise by two fundamental mechanisms: (1) habitat loss via increased tidal inundation, marsh erosion, and associated changes in vegetation (Donnelly and Bertness 2001, Raposa et al. 2017, Eckberg et al. 2017, Watson et al. 2017, Adamowicz et al. 2020); and (2) increased frequency of nest-flooding events leading to nestling mortality (DiQuinzio et al. 2002, Bayard and Elphick 2011, Ruskin et al. 2017). Field et al. (2017) used population-simulation models to estimate that rising sea levels would drive the species to extinction as soon as 2035.

Why document the ontogeny of a species that is likely heading toward extinction in the next decade or two? What do we *not* know about the Great Auk (*Alca impennis*) or the Laughing Owl (*Sceloglaux albifacies*) that would have illuminated our understanding of the intersection of habitat, human behavior, and survival—before it was too late?

The Saltmarsh Sparrow Research Initiative (SSRI—https://www.salsri.org/) has documented the breeding ecology of SALS at Jacob's Point in Warren, Rhode Island, from 2017 through 2021 (Reinert et al. 2021). Over those five years, we located a total of 243 SALS nests clustered over 14 hectares of salt marsh, and have monitored more than 750 nestlings. Nests are usually found early in the breeding cycle by locating females who are incubating eggs; however, we sometimes find nests with chicks already present, and need to determine their age to document the timing in the nesting cycle with regard to flooding and depredation events. Aging chicks correctly also allows us to band them—ideally on Hatch Day 6 or 7, before the risk of force-fledging them out of the nest. For these reasons, it is helpful to have both physical and behavioral descriptions for each day in the life cycle of SALS nestlings. Our starting points were generic descriptions of songbird development (Jongsomjit et al. 2007) and a preliminary description of SALS nestling development (SHARP 2011), augmented by our own observations and experience. Our objective with this report is to create a resource that will be useful to all researchers working on the species along the East Coast—thereby enhancing conservation efforts as much as possible.

We have also created an accompanying Google Slide document containing short videos of SALS nestlings at different ages, which can be accessed at https://tinyurl.com/agingSALS.

Hatch Day 0

The eyes are shut for the first several days in this altricial species. Note the whitish egg tooth (arrow) and the presence of matted down on the head. The body appears naked with the skin seeming translucent, especially over the pygostyle (rump). The abdomen is markedly distended. Hatchlings are capable of extending their necks briefly against gravity, but with little motor control. They beg with an open yellow gape, emitting a peep that is audible to the SALS female, but barely perceptible to humans.

Hatch Day 1

The eyes remain tightly shut and appear disproportionately large with regard to head size. Capital down (on the head) appears sparse and fluffy. Evidence of feather papillae is beginning to emerge as bumps on the skin of the dorsal (spinal) tract. Skin continues to appear translucent, revealing vascularization. Head control has improved to allow holding a neutral position momentarily. Begging behavior emerges when nearby vegetation is disturbed. Nestlings stay in close physical contact with each other from Hatch Day 1 until fledging at Hatch Day 9 or 10. In nests containing a single nestling and egg, the chick will flex around the egg maintaining almost constant contact.

Hatch Day 2

Papillae are visible on alar (wing) and dorsal tracts. The eyes remain tightly shut, and the skin appears opaque. Note the white fecal sac (arrow) on the nestling to the left in the photo. Females remove small fecal sacs frequently, keeping the nest clean. Posture is primarily one of spinal flexion, allowing for constant contact with another chick and subsequent heat conservation. The legs are strong enough to extend and flip the nestlings uncontrollably from front to back, as in reaction to an insect in the nest (see video linked above).

Hatch Day 3

Primary and secondary alar tract pin feathers are distinctly seen, as are dorsal pins. Papillae are beginning to emerge over the femoral (leg) tracks, but are faint. Neck strength is adequate to lift the head up for a few seconds but head control will not develop until the eyes are open. Chicks move all limbs slowly, extending against gravity. Hearing is developed enough that nestlings will extend their necks and open gapes widely when hearing any undifferentiated sound.

Hatch Day 4

The eye openings are restricted to narrow slits. Remiges (flight feathers) are emerging. Pins can be seen over the humeral tract (upper limb), but are still absent from the femoral tract. Large featherless areas (apteria) are visible between the tracts. Begging is generally silent when disturbed. The legs are stronger and more mobile than the wings, which will continue through the fledgling stage. Nestlings alert to the sound of a female chipping nearby and will open their eyes wider and rotate their necks in all planes, looking for the female.

Hatch Day 5

All feathers are still sheathed, with lightly colored tips visible as they emerge further on the wings. Note the first appearance of retrices (tail feathers). Toes appear disproportionately long. The egg tooth is gone and ear openings are obvious. Nestlings now beg silently when disturbed, with eyes open. They are capable of sitting unsupported, but lose balance when falling asleep in this position (see video linked above). Nestlings will counter-chip when hearing a female's alert call as far as 10 meters away.

Hatch Day 6

The eyes are fully open. Feathers have a bluish tint. Apteria surface area is diminishing, but there are still bare areas lateral to the spine. The tips of body feathers and secondary feathers are unsheathing but primary feathers lag behind, still sheathed. Head control is well developed, allowing nestlings to track movement visually in all directions. Nestlings at this age tend not to beg when disturbed, but may cower silently.

Hatch Day 7

Coloring begins to shift from blue to brownish-gray as the sheaths over the remiges slough off. Motor activity increases with active leg extension and increased wing flapping, but chicks lack the strength and coordination to climb out of a flooding nest (see video linked above). Chicks are able to support their body weight on their legs and are at an ideal age for banding. Distress calls replace begging; the female responds by counter-chipping and flying in a semi-circular pattern near the nest.

Hatch Day 8

Body feathers are mostly unsheathed while flight feathers are still emerging from sheaths and capital feathers lag behind. The ventral (underside) tract appears yellowish with chest streaking. Nestlings rarely beg when disturbed at this age, but emit a distress call (audible to humans). When handled, 8-day old nestlings attempt to escape the nest and have been filmed successfully climbing vegetation to avoid incoming tides that are flooding the nest (see video linked above).

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Hatch Day 9

Overall appearance is colorful, with a wide, dark line behind the eye contrasting with brownish auricular (the area around the ear opening) and yellow gape. Buffy underparts and brownish upperparts are apparent. By Hatch Day 9, the nest appears too small to accommodate four chicks and fecal material is often present on the rim of the nest. Most SALS nestlings fledge on Hatch Day 9 and are fully feathered. They are reliant upon leg strength for mobility in running through the salt marsh grasses and are capable of short hops, but not sustained flight.

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