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Abstract: Crane chicks are dependent on parent birds for provisioning during the first few months of life, but no study has examined this provisioning in detail. In 2014 research staff at the U.S. Geological Survey, Eastern Ecological Science Center (formerly Patuxent Wildlife Research Center), in Laurel, Maryland, made multiple observations of parent whooping cranes (*Grus americana*) feeding or interacting with their chick during the 3 months from hatching to fledging. Both parents participated in the feeding of the chick and only 1 chick was raised by each pair of parent whooping cranes. Initially feeding frequency was low (0-20 times per hr), but as the chick absorbed its yolk sac and required food, feeding frequency increased to a high of 105 times per hour. Whooping crane parents fed their chick from 0 to 105 times per hour. Feeding frequency peaked around day 19, then decreased after the chicks reached 40 days of age but continued at a low level during the entire 3 months from hatch to fledging. Because feeding frequency observed for this study was very low at fledging, the use of feeding by alloparents as a measure of chick-alloparent bond may not be practical.

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Avian parents raising young that require parental care need to decide 1) if they will go foraging or do some other activity, 2) if foraging, they need to decide what food items to harvest, and 3) whether to eat the food item themselves or feed it to their chicks (Nur 1987). Levels of feeding young birds appear not to be fixed but a dynamic process based on the growth needs of the young chicks and the increasing ability of chicks to procure their own food as time passes (Nur 1987). Unlike passerine models examining feeding frequency by parent birds to multiple brood members, where brood size at some point becomes adversely related to brood success due to the parent birds' inability to adequately provision the brood, no such problem exists with whooping cranes. Two parent whooping cranes (*Grus americana*) have a more than adequate ability to provision 1 or even 2 chicks.

Whooping canes have been the subject of several reintroduction programs (Sadowski et al. 2018, Neri 2020). In these reintroduction programs, whooping crane colts (term used for post-fledged chick) reared in captivity by parent birds (parent-rearing) were sometimes released with wild pairs of whooping cranes to act as alloparents (other or different birds acting as parents). One hypothesis to measure the alloparent-colt bond is to measure the frequency of feeding of the colt by the alloparents. The reintroduction program for the Florida non-migratory population was the first program to use captive parent-reared whooping crane colts for release into the wild (Folk et al. 2010). Building on those early results, recent efforts have used the parent-rearing technique developed at U.S. Geological Survey, Eastern Ecological Science Center, formerly Patuxent Wildlife Research Center (Laurel, Maryland, USA), to introduce whooping cranes into the Eastern Migratory Population (EMP) in Wisconsin (Sadowski et al. 2018). Between 2013 and 2015, 11 whooping crane parent-reared colts were introduced at the Necedah National Wildlife Refuge, Necedah, Wisconsin. In 2016, the introduction of parent-reared whooping crane colts was increased, with 14 captive parent-reared colts produced and 11 introduced into the wild in a larger area in central Wisconsin. This was followed by 12 captive-reared colts produced and released in 2017 (Thompson et al. 2022).

One strategy of these reintroductions was to locate potential alloparents for the colts. The expectation was that the alloparents would bond with and care for the colt after release and lead it on the southbound fall migration to the wintering area of the alloparents, possibly also leading the colt back north in the spring. Several behavioral observations were used to measure the degree of the alloparent bond observed in the wild. One such behavioral observation is the feeding of the colt by the alloparents. The assumption is that alloparents will be actively feeding the colts in the fall. This captive study was designed to measure the frequency of feeding by parents at various periods during the rearing of the chick/colt. Parent feeding of chicks in captivity is easily observed using remote cameras but has never been well documented. In 2014 we made multiple observations of

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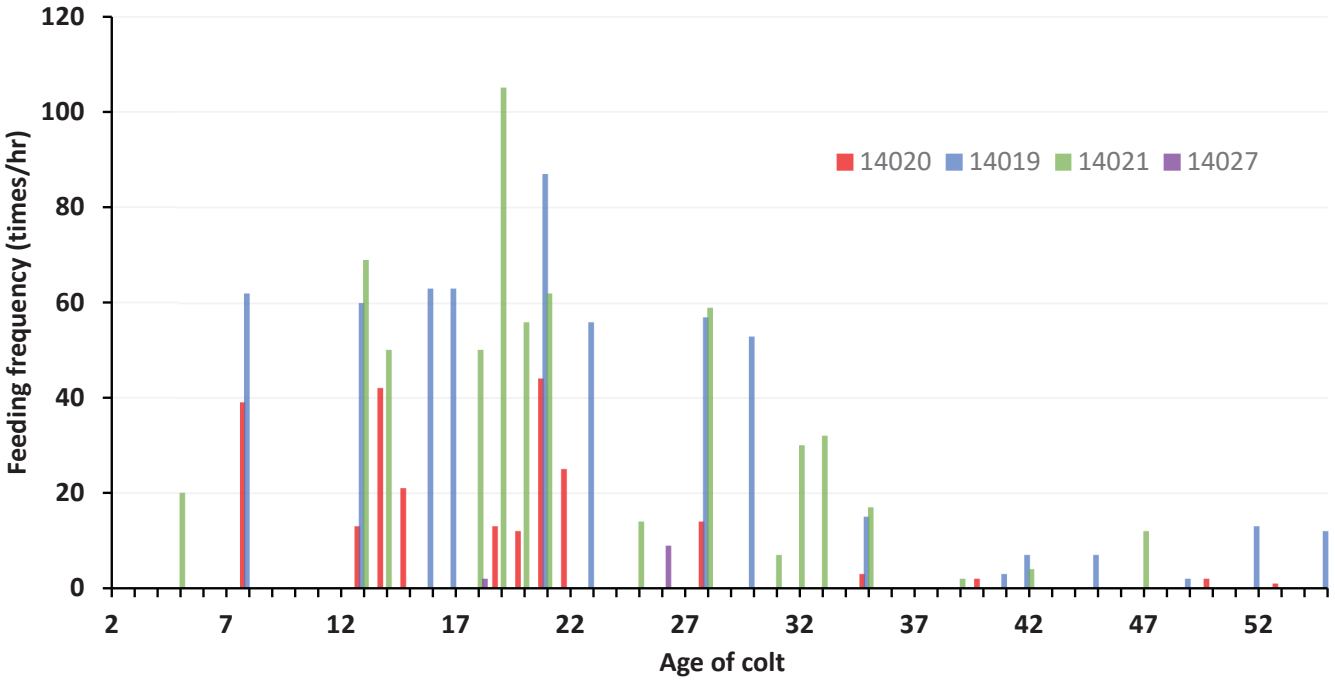

Figure 1. Times per hour that 4 whooping crane chicks were observed being fed by parent whooping cranes, as measured by bill-to-bill contact, from hatch to fledge in captive facilities at U.S. Geological Survey, Eastern Ecological Science Center (formerly Patuxent Wildlife Research Center), Laurel, Maryland, June-September 2014.

whooping crane parents feeding chicks over a period of 3 months from shortly after hatch to fledging. This information can be useful when observing chick/colt interactions with parent birds in the wild.

Established captive parent-rearing methods were followed (Ellis et al. 1996, 2001). This study used cameras to observe parent-chick interactions for 4 whooping crane chicks. Each chick had 2 parent whooping cranes. All whooping crane parents were experienced in rearing chicks. No non-camera observations were used for this study, as the presence of the observer would potentially disrupt the feeding behavior. Any close contact between the bill of a parent and the bill of a chick was considered a feeding event. We could not often see the item being offered by the parent to the chick. Even adult whooping cranes often eat very small food items (Neri 2020). All observations were made on chicks and parents outside of any building or structure such as a feed shed.

All observations were made during daylight hours from 0800 to 1500 hours Eastern Daylight Time. Observations began after 0800 hours because before this time crane team members would be walking through the crane colony making daily animal welfare observations and creating a possible disturbance that would disrupt behavioral observations. The time to start observations was chosen randomly after this period. Then all pens in an area were observed for 15 minutes in a random order at the time selected. In some cases, especially when the chicks were young, 2 observation periods were conducted per day.

Whooping crane chicks interacted with their parents from 0 to 105 times per hour (Table 1, Fig. 1). Initial observations of feeding by parent whooping cranes were low because the small chicks were at times difficult to see in tall grass. Also, the nutrient requirements of the small, recently hatched chicks are low, as the chicks absorb nutrients from their yolk sacs. Observations of feeding behavior of newly hatched, costume-reared, whooping crane chicks show the same pattern of limited or no feeding of offered food during the first 24-48 hours (Hartup and Horwich 1994).

Feeding frequency peaked between days 8 and 28 of age, and thereafter the number of observed feedings by parent whooping cranes decreased. This corresponded to the chicks doing more foraging and feeding on their own and requiring less feeding by the parent birds. By the time the chicks were released to alloparents in Wisconsin sometime after day 90 of age, the number of feedings done by the whooping crane parents had essentially dropped to 0 per observation period. Looking

Table 1. Chick feeding frequency by adult parent whooping cranes at U.S. Geological Survey, Eastern Ecological Science Center (formerly Patuxent Wildlife Research Center), Laurel, Maryland, June-September 2014. Observation periods were 15 minutes.

Date	Bird ID	Age (days)	Temperature (°C)	Weather	Start (hr)	Times fed per hour
9 Jun	14020	4	21.1	partly cloudy	1000	0
11 Jun	14020	6	23.8	overcast	1035	0
12 Jun	14020	7	21.1	rainy	1210	0
13 Jun	14020	8	21.1	overcast	815	39
16 Jun	14020	11	26.1	sunny	1145	0
17 Jun	14020	12	23.8	sunny	930	0
18 Jun	14020	13	27.8	sunny	820	13
19 Jun	14020	14	29.4	cloudy	1457	42
20 Jun	14020	15	17.2	sunny	800	21
24 Jun	14020	19	27.2	sunny	1335	13
25 Jun	14020	20	25.6	overcast	800	12
26 Jun	14020	21	25.0	partly cloudy	1030	44
27 Jun	14020	22	25.0	sunny	1045	25
1 Jul	14020	26	38.8	partly cloudy	1355	0
3 Jul	14020	28	22.7	partly cloudy	855	14
10 Jul	14020	35	25.0	partly cloudy	1010	3
14 Jul	14020	39	26.1	partly cloudy	1440	0
15 Jul	14020	40	27.8	sunny	1040	2
22 Jul	14020	47	22.2	cloudy	850	0
23 Jul	14020	48	31.1	sunny	1323	0
25 Jul	14020	50	15.0	sunny	810	2
28 Jul	14020	53	16.1	cloudy	850	1
1 Aug	14020	87	27.8	sunny	1103	0
4 Sep	14020	91	25.0	partly cloudy	1117	0
5 Jun	14019	2	18.3	partly cloudy	1127	0
5 Jun	14019	2	12.8	partly cloudy	835	0
9 Jun	14019	6	30.0	overcast	1525	0
11 Jun	14019	8	32.2	partly cloudy	1315	62
11 Jun	14019	8	27.2	sunny	1355	0
12 Jun	14019	9	23.8	overcast	1435	0
12 Jun	14019	9	38.8	sunny	1415	0
16 Jun	14019	13	27.8	sunny	1315	60
19 Jun	14019	16	25.6	partly cloudy	945	63
20 Jun	14019	17	22.7	sunny	1243	63
24 Jun	14019	21	22.7	sunny	1143	87
26 Jun	14019	23	21.1	partly cloudy	835	56
27Jun	14019	24	27.8	sunny	1415	0
1 Jul	14019	28	22.7	sunny	840	57
3 Jul	14019	30	27.2	sunny	1117	53
8 Jul	14019	35	30.0	sunny	1115	15
14 Jul	14019	41	25.0	sunny	1145	3
15 Jul	14019	42	27.2	partly cloudy	1120	7
18 Jul	14019	45	21.7	partly cloudy	1050	7
22 Jul	14019	49	22.2	cloudy	955	2
25 Jul	14019	52	22.7	sunny	1145	13
28 Jul	14019	55	26.1	sunny	1030	12
31 Aug	14019	89	28.9	sunny	1207	0
5 Sep	14019	94	26.1	sunny	1047	0
11 Jun	14021	5	22.2	overcast	945	0
11 Jun	14021	5	31.1	sunny	1140	20
16 Jun	14021	10	17.8	sunny	845	0
18 Jun	14021	12	30.0	sunny	1155	0
19 Jun	14021	13	26.1	cloudy	1410	69

Table 1. Continued.

Date	Bird ID	Age (days)	Temperature (°C)	Weather	Start (hr)	Times fed per hour
20 Jun	14021	14	22.2	sunny	1055	50
24 Jun	14021	18	21.7	partly cloudy	830	50
25 Jun	14021	19	28.9	cloudy	1415	105
26 Jun	14021	20	27.8	sunny	1120	56
27 Jun	14021	21	25.0	sunny	930	62
1 Jul	14021	25	25.6	sunny	1152	14
4 Jul	14021	28	22.2	overcast	825	59
7 Jul	14021	31	30.0	sunny	1325	7
8 Jul	14021	32	30.0	sunny	1205	30
9 Jul	14021	33	23.8	overcast	1005	32
11 Jul	14021	35	22.2	sunny	905	17
14 Jul	14021	38	20.0	sunny	845	0
15 Jul	14021	39	27.8	cloudy	1335	2
18 Jul	14021	42	25.0	sunny	1147	4
22 Jul	14021	46	25.0	cloudy	1110	0
23 Jul	14021	47	31.1	sunny	1250	12
14 Aug	14021	69	17.8	overcast	1031	6
16 Aug	14021	71	17.2	sunny	918	0
31 Aug	14021	86		sunny	1135	0
3 Sep	14021	89	25.0	cloudy	1120	6
26 Jun	14027	13	27.2	partly cloudy	1453	0
27 Jun	14027	14	20.0	partly sunny	730	0
27 Jun	14027	14	26.1	partly cloudy	1154	0
1 Jul	14027	18	27.2	sunny	1040	2
3 Jul	14027	20	30.0	partly cloudy	1322	0
7 Jul	14027	24	20.0	partly cloudy	810	0
9 Jul	14027	26	25.0	partly cloudy	1210	9
11 Jul	14027	28	17.8	sunny	805	0
15 Jul	14027	32	21.1	partly cloudy	835	0
18 Jul	14027	35	25.0	partly cloudy	1315	0
18 Jul	14027	35	22.2	partly cloudy	855	0
22 Jul	14027	39	21.7	cloudy	1320	0
28 Jul	14027	45	22.7	sunny	950	0

at the feeding frequency by hour showed no discernable pattern. Mean hourly feeding rate was 16.1 times per hour. The mean feeding rates by hourly interval for the 90-day study period were: 0800-0900 hours, 16.2 times per hour; 0900-1000 hours, 16.1 times per hour; 1000-1100 hours, 14.1 times per hour; 1100-1200 hours, 14.6 times per hour; 1200-1300 hours, 19.0 times per hour; 1300-1400 hours, 13.1 times per hour; and 1400-1500 hours, 24.0 times per hour.

Nur (1984) proposed that feeding frequency is increased where habitat is poor and when chick weight is low. The sample size in this study was too small and the habitat of the captive center pens was too uniform to draw any conclusions about feeding frequency as related to chick nutrition or food availability. In addition to the natural foods fed by the parent whooping cranes, the parents were free to feed their chick a pelleted diet (Olsen 2009). Eventually, the chicks did learn to self-feed on the pelleted diet long before fledging.

In a recent paper on great tits (*Parus major*), van Oers et al. (2015) showed that prey selection by the parent birds was found to influence the personality development of chicks. The theory was that the different levels of taurine in spiders and caterpillars fed to offspring influenced the ability of their offspring to handle stress. Chicks provisioned with lower amounts of caterpillars (less taurine) had a stronger stress response, which the authors thought was reflected in faster exploratory behavior later in life. The current study did not identify the actual food items fed or their nutritional value. Specifically, taurine levels in the diets of parent-reared whooping crane chicks were not considered in this study. Taurine levels

in the diets of parent and costume-reared whooping crane chicks could be something that needs to be explored in the future.

So, is offering food by alloparents an observation that can be used to assess the colt/alloparent bond in the wild? This author has observed on rare occasions wild alloparents offering an introduced fledged colt (>90 days old) a food item, but the lack of such observations does not seem to translate into a poor colt/alloparent bond, as this type of feeding behavior is rarely seen at 90 days of age and beyond. Therefore, feeding of the released introduced colt by the wild alloparents is not a useful indicator of the bond between the colt and the alloparents.

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