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Full Length Research Paper

Population sizes of cotton pygmy-goose *Nettapus coromandelianus coromandelianus* Gmelin in some places of Assam (India)

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The breeding season is of paramount importance to the population size of waterfowl. All of the increase in population size occurs, as does much of the mortality during that season, which is often but a fraction of the entire year. Population of a species is indicative of the environmental factors of that area which strictly influences the species. The study includes the population size of the Cotton Pygmy-goose *Nettapus coromandelianus coromandelianus* Gmelin, a least concern anatid of South-east Asia and near relatives of Pygmy-goose of New South Wales which is under threatened condition. The study also includes the parameters influencing the population sizes. Two hundred and three (203) Cotton Pygmy-geese were observed during breeding season in 2006 and 2009 in study sites of Assam. Adult survival rates were found high 0.99 to 0.94 (SE < 0.005), but duckling survival was much lower, varying from approximately 0.1 to 0.3 during 2007 to 2009. No naturally died specimens have been collected during the study period, but 7 specimens have been reported to be killed by hunters among a total of 22 gooses were killed during 2006 to 2008. The present paper deals with the population dynamics of Cotton Pygmy-goose with special mention of the factors affecting their survival.

Key words: Breeding, environmental, mortality, population, waterfowl.

INTRODUCTION

The Cotton Pygmy-goose (CPG) is a non-migratory dabbling duck (Anseriformes: Anatidae: Anatini) endemic to South-east Asia. Compared with the other dabbling ducks, the species has fairly high power of flight and other terrestrial adaptations. It is fairly common during the cold weather until the end of April and was observed in the inland tanks, with overgrown water plants in Tinnevelly district of South India (Fleming, 1898). Parrington (1903) and Gibson (1908) observed the distribution of CPG in Sind. Bacon (1908) has observed three CPGs in the Konkan (Western India). Mitchell (1914) observed the CPG in a region so far removed from his usual habitat and detected two CPGs in Kashmir. In Blandford's Fauna (1898) the CPG was said to occur throughout the greater part of India, and neighboring countries to the east, but to be rare in Malabar, the Bombay Presidency, and Kathiawar (Abdulali 1962). The *N. coromandelianus coromandelianus* Gmelin is distributed with a breeding habitat in South Asia, East and South-east Asia with a population of 125,000 to 1,100,000 (Delany and Scott, 2002). The South Asian sub-species have 1% level at 1,000 (Li and Mundkur, 2007). The Australian species of *Nettapus* that is to say, *N. albipennis* is solely distributed within the Australian rage with breeding capabilities and has a population of 7,500 with 1% level at 75. The African Pygmy goose, *N. auritus* is distributed in West Africa, Southern and Eastern Africa and Madagascar. Its population in Southern and Eastern Africa is estimated to be in between 100,000 to 250, 000 with 1% at 1,750. In Madagascar, *N. auritus* has a population range of 5,000 to 10,000 with 75 at 1% level. The Green Pygmy-goose, *N. pulchellus* is distributed all over the Northern Australia and Southern New Guinea (Perennou et al., 1994).

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The CPG has a large population estimated to be 59,000 - 1,100,000 individuals with an estimated global extent of 1,000,000 - 10,000,000 km^2. Global population trends have not been quantified, but the species is not believed to approach the thresholds for the population decline criterion of IUCN Red List. For these reasons, this species is considered as Least Concern (Birdlife International 2004). The sub-species *N. coromandelianus coromandelianus* Gmelin occurs in South-East Asia with no record of occurrence in Australia. It is resident but local, practically throughout the Indian Union, both Pakistan's, Nepal terai, Ceylon, Straggler to Andaman and Maldives Island. It is distributed from plains to c.300 meters altitude. Though commonest in Pakistan, Punjab and Rajasthan but not recorded from Kerala till 1983 (Ali and Ripley, 1983).

The CPG is widely distributed within its range, with 8 sites meeting the 1% criterion in India. A large concentration of birds was reported at Chilika Lake in India with peak count of 30,534 during 2002. During 2003 and 2004 the peak count was made with 2,088 and 4,000 at Denua in Orissa and Kallur Tank in Karnataka (Li and Mundkur, 2007). Its population is going to be more or less vulnerable to be as threatened from the chance events such as severe weather, diseases and other natural as well as, anthropogenic activities as predator. Nesting success and duckling survival also are difficult population parameters to estimate. Nests are well concealed in the tree holes, and the duckling in the feeding condition is very difficult to detect as they frequently dive under the water.

The study of the population extent of the CPG from the North-Eastern region of India is quite irregular since the past. Maximum count during 2001 to 2005 was found at Kokilamukh (Jorhat district) of Assam and was 72 in the year 2004 (Rahmani and Islam, 2008). The present paper discusses the present population sizes of CPG in relation to the mortality factors affecting their survival in the study area during 2007 to 2009.

METHODOLOGY

Study sites

Sixteen wetlands of Assam were selected for the study of population of Cotton Pygmy-goose during 2006 to 2009. Mid-winter counts were made in Ajala suti, Belsiri, Boalmari, Borsola, Dhandi, Gajalmari, Kankati, Ouguri, Rikamari, Sahala, Samarajan and Satajan. Seasonal counts were made at Bordoibam Bilmukh, Dighali wetland, Kadamani wetland and Kuwari fish culture pond.

Population monitoring

Surveys

Three days continuous survey were made since 2007 by walking around the wetlands and counted all the goose visible around each wetland, beginning early in the morning one hour before sunrise till completing the round of each wetland. Birds were counted using binoculars (20 × 50) and tally counter was used as per requirement.

Brood monitoring

During the breeding seasons in 2006, 2007 and 2008, broods were checked daily around the Kadamani wetland using a telescope (Tasco 25 × 30) and binoculars (20 × 50). In 2006, brood sightings were recorded incidentally, approximately four times per week. Adults were identified and all ducklings were counted and assigned to an age class based on plumage characteristics as per Gallop and Marshall (1954). Age categories included: stage-I) the downy stage from 1 to 3 days; stage-II) ducklings in full patchy black and white feather covered; and stage-III) the fully, more or less grey feathered post-fledglings.

Mortality factors

All ducklings and adult carcasses incidentally found on the studied area were collected and preserved in 10% formalin for further study. Carcasses were measured, given external examinations and later covered by earth.

Data analysis

Data collected during the study period (pre-breeding period, breeding period and post breeding period) were used in the analysis. Survival and detection probability can be estimated for multiple periods within a year. Adult survival (φ) probabilities were estimated over three months time periods as per White and Burnham (1999). The estimate of survival is actually non-apparent survival, because Cotton Pygmy-goose emigrates from the wetland to the nearest trees or wetlands nearby.

The protocol for monitoring Cotton Pygmy-goose has not been quantified in the studied wetland prior to this study, except the records made during 2004 to 2006 (Upadhyaya, 2006). Population estimates were made based on detection probability obtained from census data collected by point count method as per Bibby et al. (1992) and Javed and Kaul (2002). Multiple surveys were conducted within a time period from 2006 to 2009 to estimate population size by calculating the average number of goose seen for a given period, divided by the mean detection probability for that period, with the variance of a ratio (Seber, 1982):

$$N_i = n_i / dm_i$$

Where n_i is the total of known birds observed and dm_i is the detection probability. Assumption was made that detection probability, which relates to Cotton Pygmy-goose's breeding phenology, remains constant per period since no data was recorded in the past from the studied wetland. Although this assumption may be violated some years due to variation in breeding conditions, it does not provide estimates that suggest population trends.

The old-aged trees irrespective of species but with distinct hollows or holes (natural or made by wood peckers) were visited during the breeding period in 2007 and 2008 to locate nests and determine nest success. Hatching success was determined by counting the number of egg shell membranes and unhatched eggs remaining. Eggs were counted at some active nests, but were not removed or handled to reduce the risk of damage or attracting the predators. Because of these constraints, 'apparent nest success' was reported instead of Mayfield's daily survival rates for nests (Sargeant and Raveling, 1992). Again apparent nest success rates were often inflated, because many nests were destroyed before they were found. Calculation of daily survival rates of nests

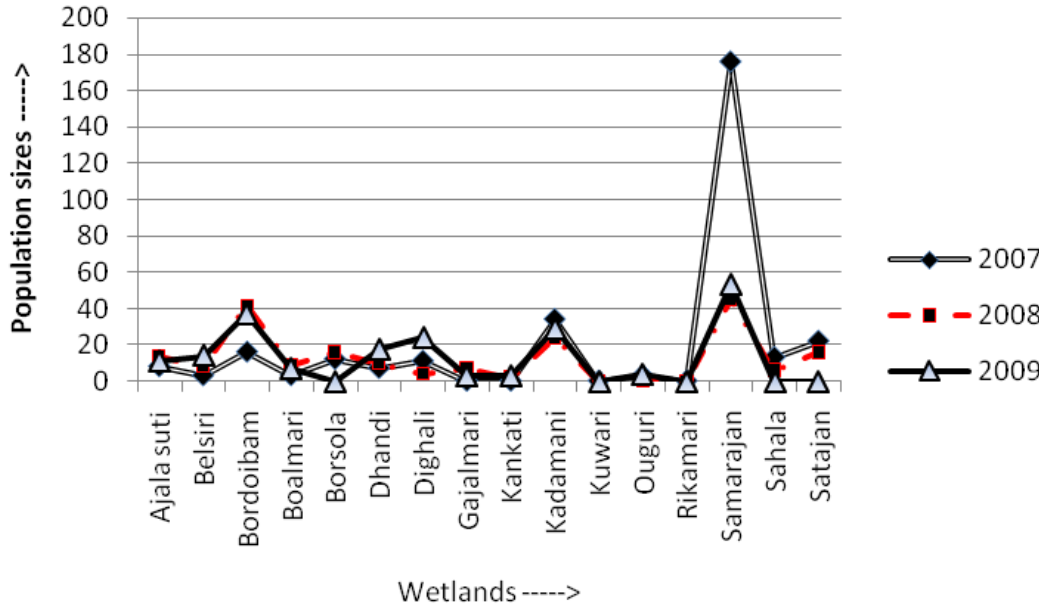

Figure 1. Population estimates of Cotton Pygmy-goose in selected sites of Assam, 2007 – 2009.

typically requires determination of age of the eggs in nest when found. This was accomplished by floating the eggs in water as per Klett et al. (1986). Surveys were conducted to determine fledging success within three months of the peak of fledging during August to October of 2007 to 2008. Because fledging survival until second year is high, fledging success is similar to recruitment. Recruitment refers to the new birds entering the breeding population, often defined as the number of young females in the population in the population divided by the total number of females (Cowardin and Blohm, 1992). Fledging success was estimated as the ratio of birds entering into the population shortly after fledging was divided by the total number of ducklings produced within a breeding season or cohort (x) as an index of duckling survival to post-fledging ($\hat{S}PF$):

$$\hat{S}PF_x = \frac{n_{tx+1}}{n_{tx}}$$

Where $\hat{S}PF_x$ is the proportion of individuals (n) surviving to t+1 or fledging (Krebs, 1999) with 95% confidence limits (Zar, 1999). Assumption was made that the ducklings and fledglings from a cohort were equally observable in the brood rearing areas at the wetland. This assumption may have been violated, especially during the day of hatching when the hatchlings were dropped like stone from the nest to the ground when a few may have lost their life before reaching the ground or brood rearing areas.

RESULTS

Population estimates

The population size observed was highest in 2007 (308) and lowest in 2009 (203, Figure 1). Comparatively higher population density is observed in Samarajan and Kadamani wetland (Table 1). Known detection probability ranged from 0.122 (SE = 0.0213) to 0.215 (SE = 0.0223) while the modified detection probability ranged from a low of 0.342 (SE = 0.0241) in summer season to a high of 0.723 (SE = 0.1213) in the retreating monsoon season (Table 2). Maximum deviation in population was found during 2007 (SD = ±9.7). The population crash actually occurred after the monsoon period and was seen starting during winter of 2007. During the winter the population was initially estimated at 34, declined to 10 by summer 2008, and has increased during the retreating season. The current population size is estimated to be 203 adult birds (SD = ±27).

Nest monitoring

During 2006, altogether 140 nests (all discarded) were detected. In 2007, thirty seven live nests were detected and out of which 14 live nests were tracked for further observation. From the observation, the average clutch size found was 14.3 ± 2.2 SD with a nesting success rate of 93% (n = 14), while a success rate of 86% from 11 nests with overall nesting success of 89.5% (n = 12). Highest 100% of hatching was found in 21.6 and 7.2% of nests in 2007 and 2008 respectively (Table 3). The annual survival rate of the CPG is found to be very high with 0.97 (SE 0.004, Table 4).

Fledging success and adult survival

Survival of ducklings to post-fledging ($\hat{S}PF$) was 0.30 (95% CL) in 2007 and 0.39 (95% CL) in 2008. The mean ratio $\hat{S}PF$ for 2007 to 2008 was 0.35 (95% CL 0.30 to

Table 1. Population size and density of CPG* in some wetlands of Assam, 2007 – 09.

Name of the wetland	Population size of CPG			Density of CPG		
	2007	2008	2009	2007	2008	2009
Ajala suti	8	14	11	0.333	0.583	0.458
Belsiri	3	8	14	0.007	0.018	0.031
Bordoibam	16	42	37	0.014	0.037	0.033
Boalmari	3	9	7	0.019	0.058	0.045
Borsola	12	16	0	0.104	0.139	0.000
Dhandi	7	10	18	0.446	0.637	1.146
Dighali	11	4	24	0.067	0.024	0.145
Gajalmari	0	7	3	0.000	0.078	0.033
Kankati	0	2	3	0.000	0.021	0.031
Kadamani	34	24	29	2.267	1.600	1.933
Kuwari	0	0	0	0.000	0.000	0.000
Ouguri	3	0	4	0.214	0.000	0.278
Rikamari	0	0	0	0.000	0.000	0.000
Samarajan	176	45	53	3.911	1.000	1.178
Sahala	13	6	0	0.130	0.060	0.000
Satajan	22	16	0	1.345	0.978	0.000
Total	308	206	203	0.124	0.083	0.081

*CPG: Cotton Pygmy-goose.

Table 2. Estimated detection probability of counted birds and modified detectability using point counts during four seasons within a year. SE is given in parentheses.

Variable	Winter	Summer	Monsoon	Retreating monsoon
Known				
Detectability	0.172 (0.0365)	0.132 (0.0213)	0.215 (0.0223)	0.122 (0.0213)
Modified				
Detectability	0.371 (0.0382)	0.342 (0.0241)	0.352 (0.0312)	0.723 (0.1213)

Table 3. Nesting success summaries of Cotton Pygmy-goose in Assam, India during 2006-2008.

Summaries	2006*	2007	2008	2006-08 Summary
Nests found with eggs	140	37	83	260
Nesting attempts[1]	NA	50	89	139
Successful nests[2]	78	14	32	124
Eggs found	840	200	476	1516
Mean clutch size	10.8	14.3	14.9	40
Eggs scavenged or depredated	NA	28	58	86
Nest scavenged or depredated	32	12	34	78
Partially hatched eggs[3]	NA	8	6	14
Infertile or undeveloped eggs	NA	12	11	23
Unknown or abandoned nests	30	11	17	58
Hatched eggs	NA	152	401	553

[1]Nest may be selected but not used for egg laying; [2]At least one egg hatched as indicated by eggshell membrane; [3]Fully formed ducklings did not complete hatching, possibly abandoned due to asynchronous nest hatch.

Table 4. Adult survivorship estimates from CPG and other waterfowl species.

Species	Average annual survival (SE)	Reference
Common teal, *Anas crecca*	0.51 (0.06)	Chu et al., 1995
Cotton Pygmy-goose, *Nettapus coromandelianus*		
coromandelianus	0.97 (0.004)	Present study
Mallard, *Anas platyrhynchos*	0.59 (0.07)	Trost, 1987

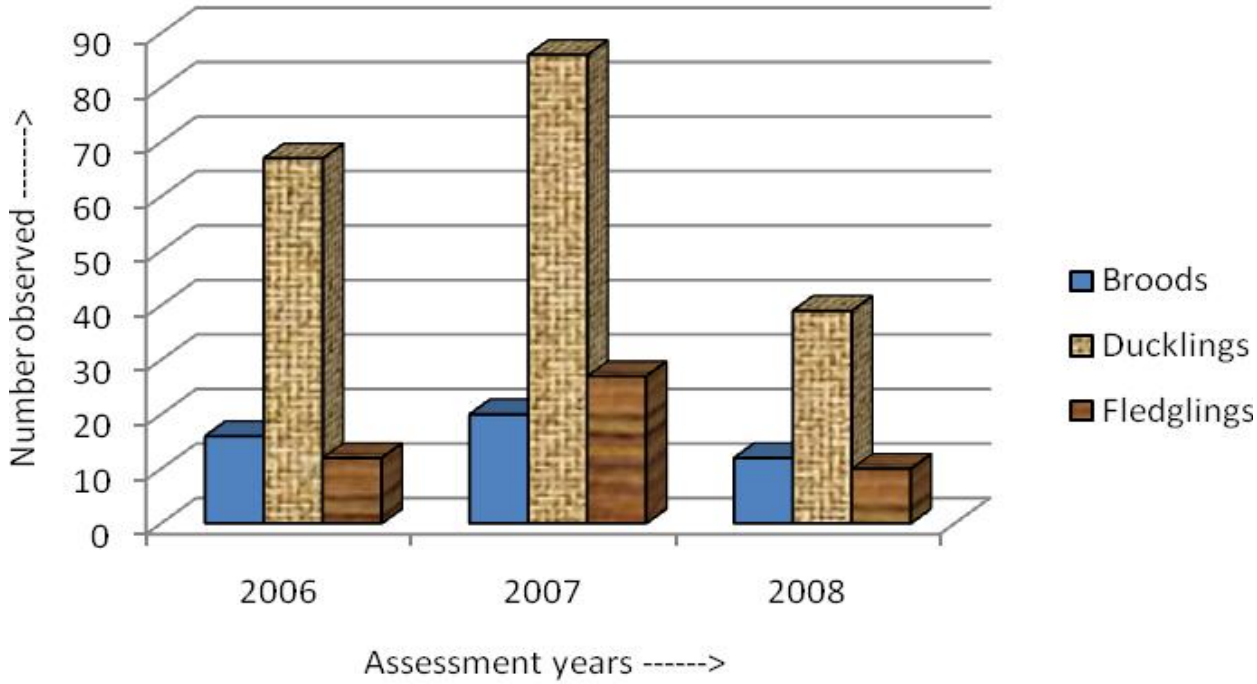

Figure 2. Reproductive success of Cotton Pygmy-goose in Kadamani during 2006 – 2008.

0.39). The number of ducklings, broods and fledglings from sighting data 2006-08 around the Kadamani wetland is depicted in Figure 2. Altogether, thirty four gooses were counted during the winter of 2008 from the Kadamani wetland with a total 203 from the study area during the study period. Examination of parameter estimates revealed that the first three periods had almost identical survival rates (0.972 to 0.993, SE < 0.004) and last one period found lower but more or less similar to each other (0.935, SE = 0.005). Recoveries were not included in the survival model because no naturally died adult carcass were found during the study period.

Causes of mortality

Data from carcasses incidentally collected during 2006 to 2008 revealed that the factor causing mortality was quite different in different localities. It is worth mentioning here that no carcass of naturally dead goose was found. All the adult carcasses found during the period were killed by humans for consumption. Of the total 17 adult carcasses (near the residents of Santals and Miri community people of Kadamani and Rajabari area) found in deplorable condition were not suitable for examination or even for morphomatric observation.

Only three duckling carcasses were found near the nesting sites. The reason might be due to physical injury during dropout from the nest on the day of hatching as slight head injury has been observed on two of the carcasses. Duckling mortality at foraging site has been ascribed to exposure of ducklings separated from the brood, especially during rainstorms (Moulton and Marshall, 1996). Feathers of eight 15 day old ducklings were found and observed at Rajabari area during September 2008. These ducklings were captured from the nearby pond and fed by the local community of the rural area.

DISCUSSION

Survival is the principal parameter shaping population dynamics and is equally important for understanding the evolution of life history characteristics in waterfowl (Johnson et al., 1992). Cotton Pygmy goose, like much other endemic goose (Lack, 1970, Weller; 1980), show K-selected traits: low adult mortality and low recruitment as compared to the continental species. It is essential to understand factors that drive annual survival of sex and age classes to manage these least concern species. Compared with the other waterfowl, Cotton Pygmy-goose has very high adult survivorship for both sexes. Limited data from recoveries suggest that post fledging survival is also high.

The Cotton Pygmy-goose's nesting biology from Indian Sub-continent is understudied, but the study shows that reproduction is highly variable depending on the environmental conditions and that clutch sizes are more or less big (Upadhyaya and Saikia, 2009). Our nest monitoring data were limited due to medial sample sizes with anthropogenic disturbances during the study period, but results indicate that apparent nest success is more or less high. No nesting records have been studied prior to the present work. The result of present study on nesting success indicates a higher nesting success at natural condition with same percent nesting success in 12 nests during 2007 to 2008.

The cause of nest failure in the South Asian species is largely due to predation, whereas causes of nest failure during this study are speculative or unknown, since few active nest checks were made. Pre-fledgling waterfowl are particularly vulnerable to mortality. Despite the importance of the pre-fledgling period to the dynamics of the waterfowl populations, brood biology is the most poorly understood aspect of waterfowl ecology (Sedinger, 1992). Few studies estimate duckling survival to fledgling and mortality rates highly variable. Mortality rates of mallard ducklings from numerous studies ranged from 0.56 to 0.66, and mortality was attributed mainly to predation and exposure (Sargeant and Raveling, 1992; Mauser et al., 1994). The importance of nutrition to duckling mortality is more difficult to assess, and has probably been underestimated (Sedinger, 1992). At natural condition the duckling survival on study area is higher, but the anthropogenic activities are the primary parameters limiting population growth. The survival of the ducklings of the CPG is very difficult to assess in natural condition due to their highly active nature in the ponds or wetlands. They disappear quickly when sighted.

Conclusion

Evidence from duckling carcasses on the study area indicates loss of ducklings' life by meager mechanical injury during drop-out on the day of hatching as they nest in quite higher position in the tree holes. No carcasses are recorded to be with trauma due to overcrowded brood rearing habitat. Direct exposure may act as an agent for duckling mortality. Mammalian predatory activities, primarily the anthropogenic activities like deforestation, struggle for nesting sites with other birds, egg predation (both by snakes, other birds and human), hunting the adults, siltation of the habitat area and clearing the vegetation from the wetlands and ponds are the major causes of its decline though its number is not reduced to a limit to place it in threatened condition. The presence of emergent vegetation on the wetland protects direct exposure during foraging by the ducklings. Management to restore freshwater seeps should be investigated. Habitat restoration may create additional brood rearing habitat, reduce overcrowding and duckling mortality due to trauma. Habitat management could be beneficial during severe droughts or improve duckling survival so as to provide more fledglings for proposed translocations.

Population counts during retreating monsoon and winter had the highest detection probabilities. Typically, birds have completed molting and during these periods are more likely to be seen, yielding the highest number of geese for annual population estimates. Point counts based on physical visits are ideal for estimating population size and sex ratios in these geographically closed populations though, the direct counts do not provide an accurate population estimate. The only drawback is that future population estimates require a portion of the population be marked periodically, because estimates become less accurate as the birds die-off. Marking the CPG requires skilled personnel and is labor intensive.

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