

Understanding the Visitation Aspect of Black-headed Gull (*Larus ridibundus*) in the Long Period at Nakdong Estuary, Busan, Republic of Korea

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Abstract: This study analyzes data in the first half of 1990 (May, 1989 - April, 1993) and mid-2000 (May, 2002 - April, 2006) to understand long-term status of black-headed gulls (*Larus ridibundus*) in the estuary of the Nakdong River under rapid changes. During the period (May, 1989 - April, 1993 and May, 2002 - April, 2003 for a total of 8 years), a total of 201,519 individuals of Laridae were discovered at the estuary and the number of the black-headed gulls (*Larus ridibundus*) was 32,538 (16.15%). Monthly average of the black-headed gulls showed that there were just a small number of individuals arrived in July and August, but the number increased from September, reached the highest in April for the first term (1989 - 1993). The second term showed that some individuals were discovered in summer (June - August), then the number increased from October and reached the peak in April. Monthly average in the latter period marked 5.7 times higher than that of the former. In the aspect of individuals, there is a significant difference between the two period ($P < 0.05$) and it is discovered that the number of individuals in 2000s (Mean = 6923.50) was higher than that of 1990s (Mean = 1211.00). Comparing individuals of gulls, herring gulls (*Larus argentatus*) and black-headed gulls for 8 years, it was found out that the herring gulls (*Larus argentatus*) showed the largest number (average = 5313.13), followed by the black-headed gulls (average = 4067.25) and gulls (average = 1207.63). The fluctuation on individuals of black-headed gulls in the mid-2000s (May, 2005 - April, 2006) recorded the average number of 472.75, then 113.50 in DMD, 244.00 in JJ and SJD, 635.25 in SJ and DY, 727.50 in LUD and 643.50 in USD, showing significant differences among regions ($P < 0.05$).

Keywords: the first half of 1990, mid- 2000, Number of individuals, Winter visitor

Introduction

The black-headed gulls featuring white-colored wings outside, pale gray on top and black-colored first feather (Lee *et al.*, 2000) are bred between 50 and 60 degrees of north latitude like the Atlantic Ocean, Europe, Russia and Kamchatka peninsula and spend wintertime in East Asia, Korea, Japan, China, Borneo, the Philippines and New Guinea (Higgins and Vavies, 1996).

The black-headed gulls are migrant birds to winter and easily found everywhere in Korea like shores, estuaries, rivers and streams in winter.

There have been few researches on the black-headed gulls (*Larus ridibundus*) in Korea other than cases mentioned in overall avifauna in Korea due to wintering.

The estuary of the Nakdong River was designated as No. 179 of protection area for endangered species (place for migrant birds in Nakdong estuary, 1966. 7. 13: 247,933,884

m²) but there are few researches on the region including the Study of Birds around the Estuary of the Nakdong River (Lee, 1983; Hong, 1997; Hong, 2003, 2004b), the Study in the Upstream of Estuary Dams in the Nakdong River and its West-nakdong river (Won 1986, 1988, 1989; Koo, 1994), Study of Shorebirds (Hong, 2005), as well as studies of Little Terns (Hong, 1997; Hong *et al.*, 1998; Lee and Hong, 2009) and Kentish plovers (Hong 1997, Hong and Higashi 2008). There are long period researches on birds in the estuary including long-term residence of *Anas spp.* (Lee and Hong, 2008), *Egretta spp.* (Hong and Lee, 2010) and black-tailed gulls (*Larus crassirostris*) (Hong and Lee, 2011).

Development of western Busan including building new ports and designating free economic zone have adversely affected the ecosystem in the estuary and it is urgent to prepare preventive measures to sustain and conserve sound ecosystems in the region not free from development.

This study analyzes data in the first half of 1990 (May, 1989 - April, 1993) and mid-2000 (May, 2002 - April, 2006) to understand long-term status of black-headed gulls (*Larus ridibundus*) in the estuary of the Nakdong River under rapid changes.

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Materials and Methods

The study was performed 1-3 times a month in the 1990s (May, 1989 - April, 1993, for 4 years) and 1-2 times a month during 2000s (May, 2002 - April, 2006, for 4 years) to figure out individuals on monthly basis (taking the number of individuals in a month for the same species).

The study areas consist of 1) DMD (Daema-deung), 2) JJ (Jangja-do) and SJD (Shinja-do), 3) SJ (Saja-do) and DY (Doyo-deung), 4) LUD (Lower Ulsuk-do) and 5) USD (Ulsuk-do).

DY and SJD are separated at the end of Myeongji and central part of the Western Nakdong River on vertical axis. DMD is located on the upper part of waterways for small boats located between DMD and JJ, LUD for the upper part of small waterways across JJ and SJD and SJ and LUD and USD for mudflat during ebb from Janglim Sewage Water Treatment Facility to the low end of the USD (Fig. 1).

The study was performed in land and water and the strip transect and the point census methods were used for the latter part. The former means investigation with naked eyes or binoculars along designated routes (Fig. 1) using small boats and the latter uses barges sporadically located or using telescope ($\times 20-60$, Sony) on deltas for places hard to approach.

The line transect (Bibby and Burgess, 1992) and the point census methods are used for lands. All the observed and identified individuals are recorded.

A total of 1,152 unidentified gulls including 2 between May, 2003 and April, 2004, 1,000 between May, 2004 and April, 2005 and 150 between May, 2005 and April, 2006 were excluded from the mid-2000s (May, 2002 - April,

2006, 4 years).

The identification and categorization were performed based on Lee *et al.*, (2000) and Howard and Moore (1994), respectively.

Statistical methods include Mann-Whitney U test to figure out fluctuation on individuals between the two terms using their average numbers and ANOVA to compare Laridae (mew gulls, black-headed gulls, herring gulls) in terms and regions. The SPSS15.0K was implemented for statistical analysis.

Results and Discussion

Overall status

A total of 201,519 Laridae of 16 species were discovered including 85,514 black-tailed gulls (*Larus crassirostris*), 9,661 mew gulls (*Larus canus*), 42,505 herring gulls (*Larus argentatus*), 5 heuglin's gulls (*Larus heuglini*), 33 yellow-legged gulls (*Larus cachinnans*), 3,014 slaty-backed gulls (*Larus schistisagus*), 69 glaucous-winged gulls (*Larus glaucescens*), 22 glaucous gulls (*Larus hyperboreus*), 280 relict gulls (*Larus relictus*), 32,538 black-headed gulls (*Larus ridibundus*), 691 saunders' gulls (*Larus saundersi*), 1 caspian tern (*Sterna caspia*), 2 whiskered terns (*Chlidonias hybridus*), 8,160 common terns (*Sterna hirundo*), 1 common tern (*Sterna hirundo minussensis*) and 17,871 little terns (*Sterna albifrons*) and 1,152 unidentified gulls.

Number of black-headed gulls

Among 201,519 individuals of 16 species of gulls observed at the 8th year, the number of black-headed gulls (*Larus ridibundus*) was 32,538 (16.15%). By the years, 729 individuals were observed in the 1st year (May, 1989 - April, 199), 601 in the 2nd year (May, 1990 - April, 1991), 1,775 in the 3rd year (May, 1991 - April, 1992) and 1,739 in the 4th year (May, 1992 - April, 1993) for the first term (May, 1989 - May, 1993). Also, 5,666 birds were found out in the 5th year (May, 2002 - April, 2003), 9,066 for the 6th year (May, 2003 - April, 2004), 7,631 for the 7th year (May, 2004 - April, 2005) and 5,331 for the 8th year (May, 2005 - April, 2006).

Monthly average of the black-headed gulls showed that there were just a small number of individuals arrived in July and August, but the number increased from September, reached the highest in April for the first term (1989-1993). The second term showed that some individuals were discovered in summer (June - August), then the number increased from October and reached the peak in April. Monthly average in the latter period marked 5.7 times higher than that of the former (Fig. 2).

As shown in Table 1, there is a significant difference in individuals between the two period ($P < 0.05$, $N = 4$, M-W's

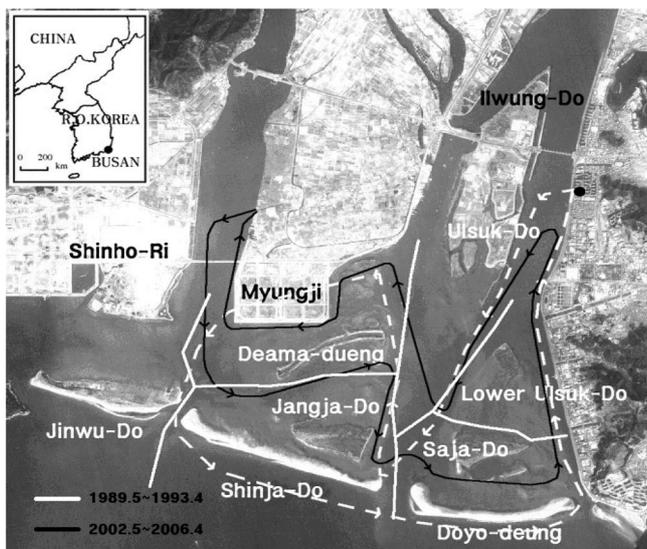


Fig. 1. Location of study site on Nakdong Estuary, Busan, Republic of Korea. Dark line shows the route for avifaunal survey from May 1989 to April 1993. White dotted line shows the route for avifaunal survey from May 2002 to April 2006.

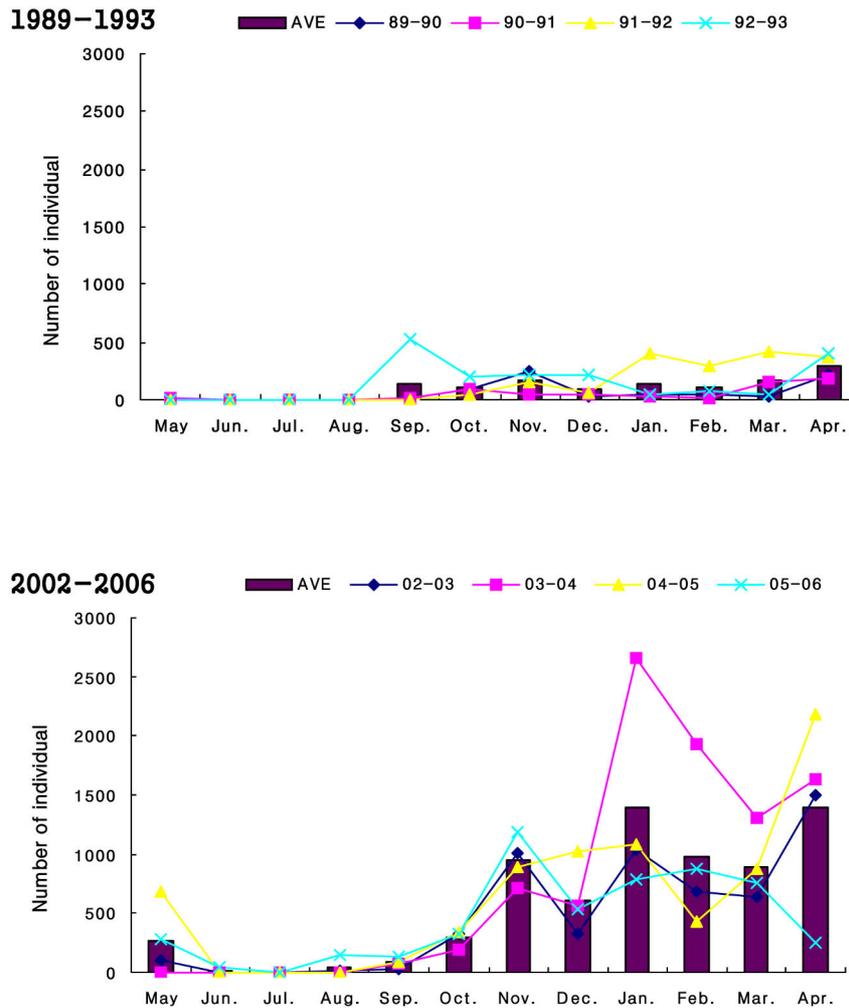


Fig. 2. Monthly change in the number of individuals in Nakdong estuary in 1989-1993 and 2002-2006

Table 1. Comparison of early 1990s to middle 2000s in the number of individuals of Black-headed Gull in the Nakdong estuary (89-93: 1989-1993, 02-06: 2002-2006)

Division	Year	Mean	SD	M-W's U	P
Early 1990s	4	1211.00	632.80		
Middle 2000s	4	6923.50	1751.97	0.000	0.029*
Total		4067.25	3287.96		

P<0.05

U) and it is discovered that the number of individuals in 2000s (Mean=6923.50) was higher than that of 1990s (Mean=1211.00).

The 8-year investigation indicated that April marked the highest number of individuals, 1,182, followed by 666 in March for the 1990s (1989-1993), as well as 5,570 in April, followed by 5,561 in January in the second term (2002-2006).

During the summer (June - August) in the first term, a total of 5 individuals were discovered including 1 in August, 1989, 2 in July, 1991, 1 in July, 1992 and 1 in August, 1992. However, 214 individuals were found out in the second term like 11 in August, 2002, 2 in June, 2003, 6

in June, 2004, 1 in July, 2004, 50 in June, 2005 and 144 in August, 2005, suggesting increase in numbers during the summer in the second term.

Comparing numbers of mew gulls, herring gulls, and black-headed gulls

Of the 201,519 individuals of 16 species observed during early 1990s (1989-1993) and mid-2000s (2002-2006), gulls, herring gulls and black-headed gulls account for the major part as wintry migrant birds. The total number is 84,694 (42.01%) including 9,661 gulls, 42,505 herring gulls and 32,528 black-headed gulls. ANOVA is implemented to figure out fluctuation on types for the 2 terms using average

Table 2. Changes of winter visitor gulls in the number of individuals in Nakdong estuary in 1989-1993 and 2002-2006

Division	Year	Mean	SD	F	P
Mew Gull	8	1207.63	1325.82		
Black-headed Gull	8	4067.25	3287.96	4.091	0.032*
Herring Gull	8	5313.13	3664.41		
Total		3529.33	3315.76		

P<0.05

1989-1993

Division	Year	Mean	SD	F	P
Mew Gull	4	51.50	42.71		
Black-headed Gull	4	1211.00	632.80	7.315	0.013*
Herring Gull	4	2134.00	1176.43		
Total		1132.17	1130.95		

P<0.05

2002-2006

Division	Year	Mean	SD	F	P
Mew Gull	4	2363.75	731.68		
Black-headed Gull	4	6923.50	1751.97	24.153	0.000***
Herring Gull	4	8492.25	1730.96		
Total		5926.50	3028.41		

P<0.01

numbers of three groups (Table 2).

As shown in Table 2, there are significant differences in numbers for the whole years (P<0.05) and herring gulls mark the highest number (average=5313.13), followed by black-headed gulls (4067.25) and gulls (1207.63).

There are significant differences in numbers in the first term (p<0.05, N=4) and herring gulls mark the highest number (average=2134.00), followed by black-headed gulls (1211.00) and gulls (51.50).

There are significant differences in numbers in the second term (P<0.001, N=4) depending on species and herring gulls mark the highest number (average=8492.25), followed by black-headed gulls (6923.50) and gulls (2363.75).

Number of black-headed gulls in regions

In the second term, the number of individuals by regions showed 454 in DMD, 976 in JJ and SJ, 2,541 in SJ and DD, 2,910 in LUD and 2,574 in USD (Fig. 4, Table 3).

ANOVA verification using regional averages was performed to find out regional fluctuation of black-headed gulls observed in the mid-2000s (May, 2002 - April, 2006) (Table 3). As shown in Table 3, the fluctuation on individuals of black-headed gulls in the mid-2000s (May, 3 - April, 2006) recorded the average number of 472.75, then 113.50 in DMD, 244.00 in JJ and SJD, 635.25 in SJ and DY, 727.50 in LUD and 643.50 in USD, showing significant differences among regions (P<0.05).

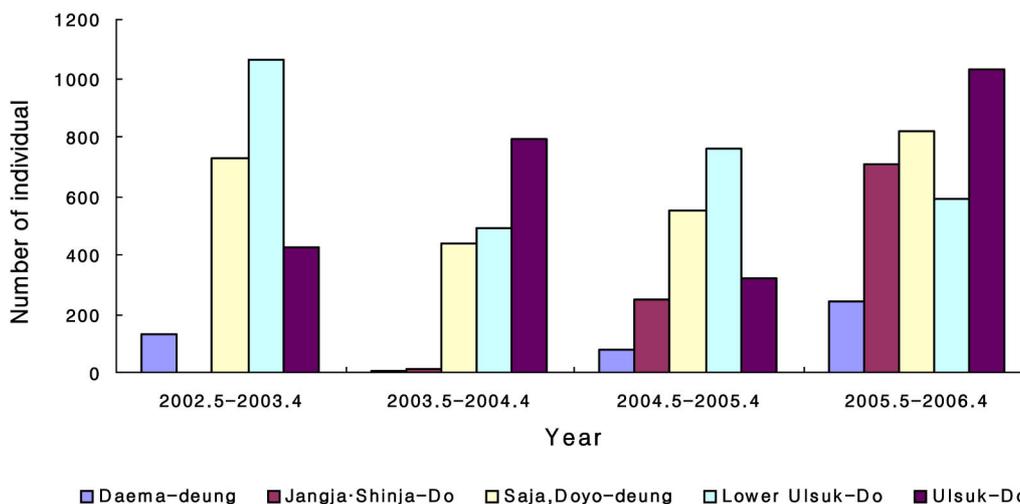


Fig. 3. The number of individuals of Black-headed Gull at 5 region in the Nakdong estuary between May 2002 and April 2006.

Table 3. The number of individuals of 5 region in the Nakdong estuary from May 2002 to April 2006 (DMD: Daema-deung, JJ.SJD: Jangja.Sinja-do, SJ.DY: Saja-do.Doyo-deung, LUD: Lower Ulsuk-do, USD: Ulsuk-do)

Site	Year	Mean	SD	F	P
DMD	4	113.50	99.08		
JJ.SJD	4	244.00	330.29		
SJ.DY	4	635.25	171.9	4.738	0.011*
LUD	4	727.50	249.51		
USD	4	643.50	328.36		
Total		472.75	337.4		

P<0.05

Consideration

Black-headed gulls live wetlands of shallow soil with plants around, shores or water around shores, sand hills, moors and wetlands with sea water, waste dumps, farms using sewage irrigation, or cities (Higgins and Vavies, 1996).

The Nakdong estuary located southern tip of the Korean peninsula, extruded part of the Asia continent, is the center of Central Asia and one of the most important places as stopovers for wintry migrant birds (Post 1983; Hong 1997).

During the 8-year investigation of black-headed gulls (*Larus ridibundus*), the monthly average between the early and the late terms showed 5.7 times difference, 1,210 individuals in the first term and 6,920 in the second term.

A total of 5 individuals were discovered in the first term including 1 in August, 1989, 2 in July, 1991, 1 in July, 1992 and 1 in August, 1992. Meanwhile, there were 214 individuals discovered in the second term including 11 in August, 2002, 2 in June, 2003, 6 in June, 2004, 1 in July, 2004, 50 in June, 2005 and 144 in August, 2004.

In the first period, just a few individuals were found out between July and August and the largest number was discovered between September and next April. However, some individuals came between June and August, increased from October and reached the peak in next April.

In the comparison between gulls and black-headed gulls for the whole 8 years, there were 201,592 individuals discovered and three top species were gulls (9,661), herring gulls (42,505) and black-headed gulls (32,528) and the total number was 84,694 accounting for 42.01% as wintry migrant birds.

For the whole period (8 years), herring gulls marked the highest average number of 5,310, followed by black-headed gulls (4,060) and gulls (1,200).

In the early 1990s, herring gulls recorded the highest number (2,310 on average), followed by black-headed gulls (1,210) and gulls (50). Meanwhile, it was discovered that herring gulls had the largest number of 8,490, followed by black-headed gulls (6,920) and gulls (2,360).

For the 8-year period, Laridae visiting the estuary to spend winter consists of herring gulls, then black-headed

gulls and gulls and their numbers increased more in mid-2000s than in early 1990s.

This may suggest that mudflats in the southern part of USD were the only places for migrant birds but the remaining island was for agricultural uses in the early 1990s. However, Maenggeummeorideung (Lower Ulsuk-do), Cheolsaedeung (Doyo-deung) and others were registered in 1988. DY was a sand hill only appeared during ebb early in 1990s but became a place good as habitat even during high tides in mid-2000s and mudflats were formed in the south USD, SJ and DY, expanding habitats for black-tailed gulls and bringing more individuals. It was the same for herring gulls (unpublished).

In the previous research in northern Durham, England, there were groups of herring gulls, gulls and black-headed gulls, as well as black-tailed gulls taking a rest during winter (Monaghan, 1980).

It is indicated that the number of black-headed gulls increased due to more number Laridae which like to form groups, as well as expanding habitats in the estuary.

The average number of black-headed gulls in the 5 regions was 472.75 and by regions, LUD recorded 727.50, 643.50 in USD, 635.25 in SJ and DY, 244.00 in JJ and SJD and 113.50 in DMD. The average number of black-tailed gulls in the 5 regions is 2,849.00 and DMD recorded 1,388.25, 1,254.00 for JJ and SJD, 2,534.75 in SJ and DY, 4,461.75 in LUD and 928.85 in USD (Hong and Lee, 2011). For herring gulls, the average number for the 5 places was 928.85 and 276.75 in DMD, 1,224.75 in JJ and SJD, 1,128.00 in SJ and DY, 1,117.75 in LUD and 797.00 in USD (Hong, unpublished), showing that their body sizes depended on their prey sizes (Gtmark 1984, Rome & Ellis 2004). DY and SJD, southern tip of the Nakdong estuary, have hen clams (large bivalves) from external sea are places for mid- and large-sized gulls like herring gulls and large number of mid-sized black-tailed gulls were discovered SJ, LUD and USD, internal bay and along with mainstream of the Nakdong River. This shows that black-headed gulls selected and took their preys in intertidal zones and on land (Kubetzki & Garthe, 2003) and mainly had earthworms and insect, as well as vegetables, domestic wastes or industrial wastewater.

They take preys from others or eat rotten meats, have different ways of kinds of preys depending on regions, seasons and usages and quickly adapt environmental changes (Cramp & Simmons, 1983).

Wide mudflats between SJ and LUD are places for taking preys and rests and it is judged that most of individuals are found in USD for easily taking preys from the mainstream.

There will be many environmental changes in the estuary due to 4 river project and designation as an FEZ.

Therefore, there should be eco-friendly development which conserves natural environments, as well as pursuing development, as well as continuous studies to conserve habitats and find out alternative habitats.

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