Return of chum salmon and water quality and ecology in the rivers connected with the eastern coast of Korea

Chung Il Lee*, Hyun Je Park, Jong Won Park, Seong-Ik Hong, Tae Hee Park, Hae Kun Jung, Joo Myun Park, and Do Hyun Lee

Introduction

C hum salmon, *Oncorhynchus keta* is major species which returns to rivers in Korea, and about 98% of chum salmon are returning to the rivers connecnted with the eastern coast of Korea. Returning rate of chum salmon in Korea is generally proportional to latitude, and release amount, water quality and ecological status in rivers are important factors allowing the species to return to those rivers. In the present study, water qualities and biological characteristics were monitored in five rivers from Taehwa river, the southernmost of the eastern coast in Korea to Myeongpa river, the northernmost of the coast

Observation

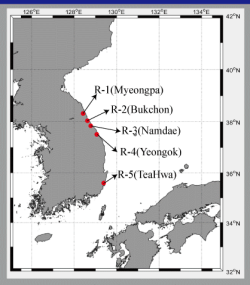

Fig. 1. The map of major returning river in Korea

1. Monitoring periods
 - Jun to Aug in 2017
 >> before or begining the returning season of chum salmon

2. Physical environment factors
 - Water temperature, Salinity and Dissolved Oxygen
 - Velocity and Discharge of flow in each region

3. Ecological status
 - Index of Biotic Intergrity (IBI)

Sum of M1 to M8
M1 : Total number of species
M2 : Benthic rapid species
M3 : Number of intolerant species
M4 : Proportion of tolerant species
M5 : Proportion of individuals as omnivore)
M6 : Proportion of individuals as insectivore
M7 : Number of individuals in the sample
M8 : Proportion of individuals with disease or anomalies

 - Korean Saprobic Index (KSI)

$$KSI = \frac{\sum_{i=1}^{n} S_i \times A_i \times G_i}{\sum_{i=1}^{n} A_i \times G_i}$$

i : number assigned to the taxon
Si : saprobic value of the ith taxon
Ai : abundance index of the ith taxon
Gi : weighting factor of the ith taxon

 - Ecological Score of Benthic Macroinvertebrate Community (ESB)

$$ESB = \sum_{i=1}^{S} Q_i$$

S : number of species
Q : ecological scope of each amimal

Results_physical environment

Physical environment factors
 - Physical environment factors were observed during the period from Jung to Aug.
 - The highest velocity of flow was recorded in R-1 (MyungPa)
 - The highest discharge was recorded in R-3 (NanDea)
 - Water temperature was increased with latitude
 - Salinity was decreased with latitude
 - Dissolved oxygen rage was between 6.9 and 7.8

Table 1 . The velocity and discharge of each rivers

	R-1	R-2	R-3	R-4	R-5
Velocity (m/s)	1.16	0.35	0.24	0.21	0.49
Discharge(m^3/s)	2.59	9.09	21.15	5.18	5.96

Table 2 . The temperature and salinity of each rivers

	R-1	R-2	R-3	R-4	R-5
Tem	18.57	20.34	21.80	24.36	25.67
Sal	0.05	0.05	1.40	2.17	3.30
DO	6.97	7.15	7.17	7.96	7.79

Results_Ecological status : fish composition

Index of Biotic Integrity (IBI)

Table 3. The standard of IBI

Level	Estimation	Index
A	Very Good	36-40
B	Good	26-35
C	Normal	16-25
D	Bad	<15

Table 4. The IBI of each region

Region	Index	Level
R_1	28	B
R_2	28	B
R_3	26	B
R_4	26	B
R_5	24	C

Korean Saprobic Index (KSI)

Table 5. The standard of KSI

Level	Estimation	Index
A	Very Good	0.00 ~ ≤1.00
B	Good	1.00 ~ ≤2.40
C	Normal	2.40 ~ ≤3.60
D	Bad	3.60 ~ ≤5.00

Table 6. The KSI of each region

Region	KSI
R_1	1.648621
R_2	0.930192
R_3	1.668377
R_4	1.310856
R_5	1.00983

Ecological Score of Benthic Macroinvertebrate Community (ESB)

Table 7. The standard of ESB

ESB Index	Condition	Water quality
>= 81	Very Good	I
61-81	Good	
41-61	Normal (Good)	II
26-41	Normal (Bad)	
13-26	Bad	III
<13	Very Bad	IV-V

Table 8. The KSI of each region

Region	ESB
R_1	37
R_2	48
R_3	87
R_4	100
R_5	83

Results_Ecological status : primary production

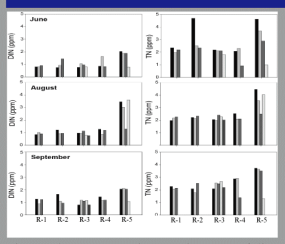

Fig. 2. The concentrations (unit, ppm) of dissolved inorganic nitrogen (DIN) and total nitrogen (TN) observed at the five stations during Jun, AUgust, and September

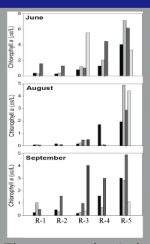

Fig. 3. The concentration (unit, μg/L) of chlorophyll a observed at the five station during Jun, August, and September

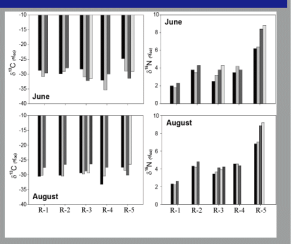

Fig. 4. δ13C and δ15N values of suspended particulate organic matter (SPOM) sampled at the five stations during June and August

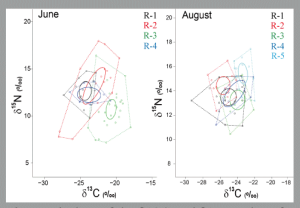

Fig. 5. Bi-plots of the δ13C and δ15N values for consumers (circles) at the sampling sites during two periods (June and August). Isotopic niche areas of consumers at the sites during the periods estimated as the total area (TA, dotted line) and standard ellipse area (SEAc, solid line).

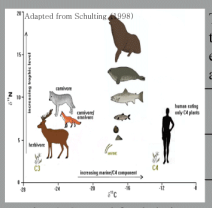

Fig. 6. General food chains

Table 9. Isotopic niche values of consumer species at the five stations during two periods (June and August) estimated as the total area (TA) and standard ellipse area (SEAc)

	Jun				Aug				
	R-1	R-2	R-3	R-4	R-1	R-2	R-3	R-4	R-5
TA	12.32	41.96	38.48	8.27	17.02	8.71	11.52	8.44	6.79
SEAc	6.4	18.26	10.12	6.45	6.69	4.13	5.15	5.31	3.44

Conclusion

In the present study, water qualities and biological characteristics were monitored in five rivers from Taehwa river, the southernmost of the eastern coast in Korea to Myeongpa river, the northernmost of the coast. The five rivers, namely, Taehwa, Yeongok, Namdaecheon, Bukchon and Myeongpa from the south to the north of the eastern coast, are situated in distinctly different environmental conditions, with the latter four rivers being surrounded by natural forests, but Taehwa river runing through large industrial and urban area before it reaches the sea. Thus, Taehwa river is expected to have poor water qualities by human induced influences, while thoes in the other rivers are improved according to the latitude and geographical features. Among those rivers, Namdaecheon, the major releasing and returning area of chum salmon has relatively good status, especially biological condition (i.e. prey, predator, competition species) compared with the other rivers, wherease in Taehwa river, prey competition for chum salmon with animals that belong to the same trophic level seems to be relatively strong, and consquencly, prey selection of chum salmon may be restricted. The results from this study will contribute in future researchs that seek the best habitate for returning chum salmons, and better predict the release/survival mechnisms of juvenile salmons in Korean river systems.