A NOVEL APPROACH TO ESTIMATE DIOXIN-LIKE COMPOUNDS THRESHOLDS: EPIDEMIOLOGICAL EVIDENCE FOR DIOXIN-LIKE COMPOUNDS EFFECTS ON VARIOUS FERAL FISH POPULATIONS

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Introduction

It is important to control dioxin-like compounds (DLCs) concentrations in various media for ecosystem conservation. In general, thresholds for conversation of feral terrestrial or aquatic organisms are estimated by toxicological test using limited species in laboratories. But this method is difficult to estimate long-term effects on wildlife populations. It is also questionable to extrapolate their experimental results to more familiar animals or more economically important animals like fisheries resources.

Using DLCs Nationwide survey data in Japan, we epidemiologically analyzed DLCs effects on 28 feral fish populations living in rivers, lakes and oceans. From these results, we also estimated their thresholds for prevention of their local extinction. This presentation shows the results for 5 freshwater species.

Materials and Methods

We used DLCs nationwide survey data in order to evaluate relationships between DLCs concentrations in the environment and information about fish species. The data were battery of DLCs concentrations in water, sediments and fish species at 218 sites all over Japan. The information was numbers of captured, average weights, average lengths, natural/cultured, lipid contents and sex.

We also used water quality nationwide survey data in order to evaluate relationships between DLCs and other contaminants. The data were constituted by many qualities and contaminants at 1718 sites all over Japan, which were DLCs, BOD, COD, pH, DO, SS, TN, TP, Cd, HCN, Pb, Cr^{6+},As, Hg, dichloromethane, CCl_4, 1,2-dichloroethane, 1,1- dichloroethylene, cis1,2-dichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, tetrachlorothylene, 1,3-dichloropropene, Thiuram, CAT, thiobencarb, benzene, Se, $N\text{-}NO^{3-}$, $N\text{-}NO^{2-}$, F,B.

DLCs were 2,3,7,8-substituted PCDDs (9 PCDDs), 2,3,7,8-substituted PCDFs (11 PCDFs) and coplanar PCBs (14 PCBs).

48 species were captured in this survey, but we selected 5 target species which were captured in many sites. They

were *Cyprinus carpio* (common carp), *Plecoglossus altivelis* (Ayu: Japanese name), *Tribolodon hakonensis*, *Anguilla japonica*, and *Oncorhynchus mykiss* (rainbow trout).

We also defined new parameter "Appearance of Target Species (ATS)" as following formula.

ATS = Number of sampling sites where target fish was captured / Total number of sampling sites

ATS values were calculated for each class made by frequency distribution of DLCs concentrations in sediment (Fig. 1). We hypothesized that there were no apparent tendency of ATS toward DLCs concentrations in sediments if the DLC toxicity effects on ATS were not very large. Therefore other stressors except DLCs were estimated to be larger in case of no tendency.

Results and Discussion

Fig. 2 shows apparent lower tendency at higher concentration for 4 species except Japanese eel. We also investigated the tendency against any other contaminants, but no apparent tendency appeared.

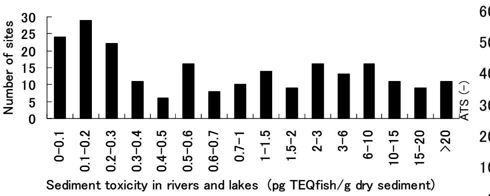
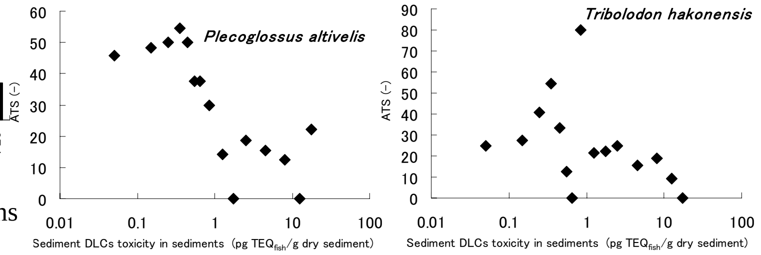


Fig. 1 Distribution of DLCs concentrations in the nationwide survey



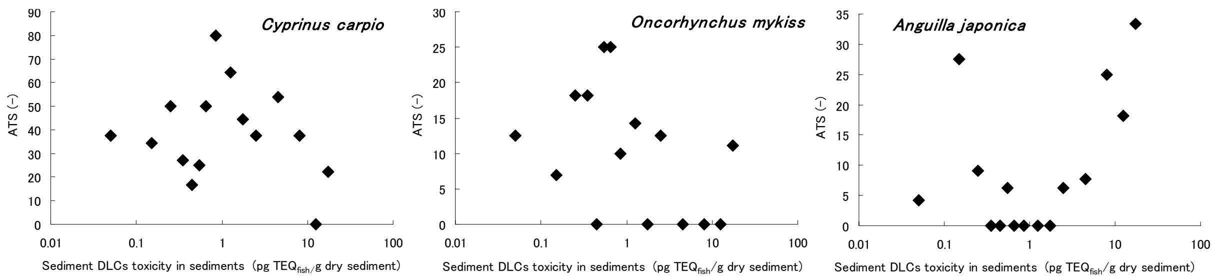


Fig. 2 The relationship between DLCs toxicity in sediments and "Appearance of Target Species (ATS)" for each 5 species

To confirm whether DLCs toxicity in sediments had a great influence on lower ATS, influence on DLCs congener profiles in fish bodies were examined. Fig. 3 have revealed that Ayu local populations captured at 68 sampling sites were divided into 4 large intraspecies groups. Other 3 fishes also could be done into some groups. Fig. 4 shows DLCs toxicity distributions in habitats of each intraspecies group. From these results, it appeared that dominant intraspecies group was significantly different between at lower and higher DLCs toxicity. It also appeared that thresholds for ATS decline were almost equal to DLC toxicity at which lower toxicity-dominant group were extinct.

On the other hand, Fig. 5 shows that DLCs congener profiles were little different among sediments at intraspecies habitats. Therefore DLCs toxicity in sediments would seem to affect ATS and difference of DLCs profiles in local populations would depend on different sensitivity to DLCs, not on DLC sources.

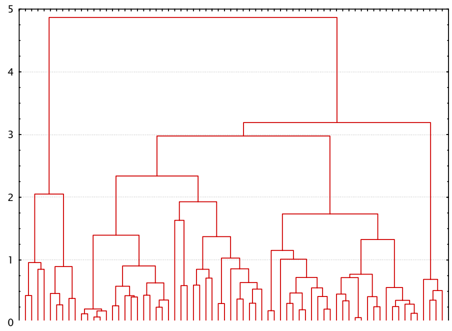


Fig.3 Dendrogram of average DLCs congener profiles in *Plecoglossus altivelis* bodies captured at 68 sites

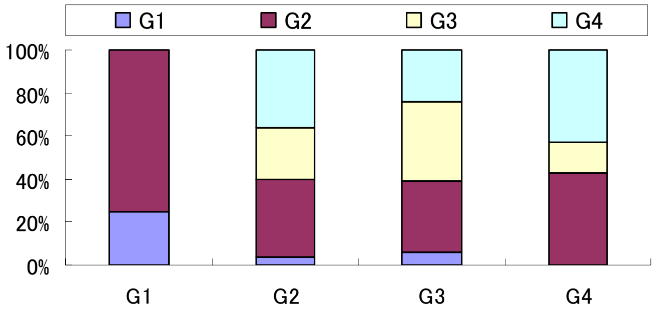


Fig.5 Sediment DLCs congener profiles of each intraspec-ies group in *Plecoglossus altivelis*

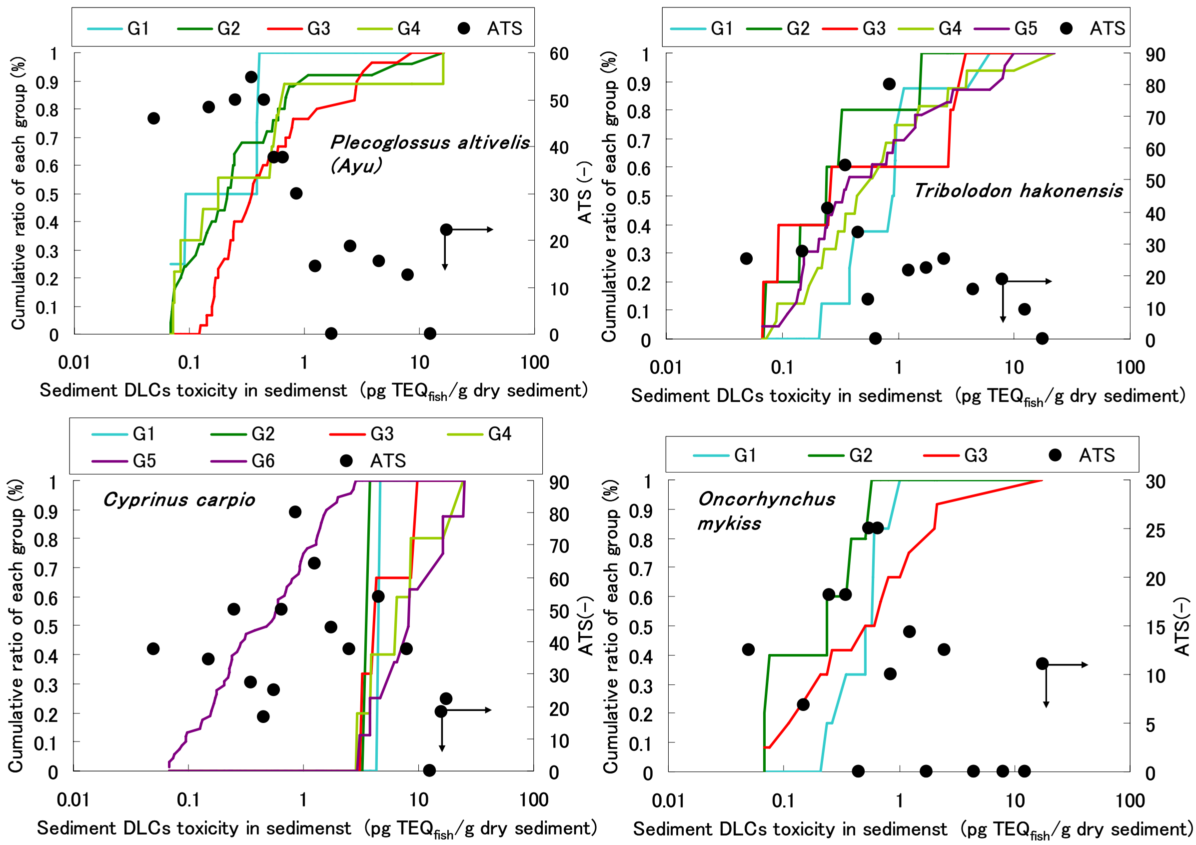


Fig. 4 DLCs toxicity distribution of intraspecies group for each 4 species

We have simulated DLCs effects on rainbow trout populations at very low level estimated above. Eggs and sac fry are more sensitive than adult fishes and the toxicity was related to DLCs through maternal transfer. Therefore we have predicted DLCs concentrations in eggs using biota sediment accumulation factors (BSAFs) repoetrd by

P.M. Cook [1]. We have also used the LOEL dose, based on survival of eggs reported by J.P. Giesy[2]. As an induction of DLCs toxicity risk to raibow trout egg, DLCs toxicity values were hypothesized to be linearly equated to a range of 0-100% mortality based on data reported by J.P. Giesy [2].

It was evident that eggs could be died at very low DLC toxicity levels we estimated and that egg survival rate was higher at higher DLCs toxicity in sediments (Fig. 7). Fig. 7 suggested that egg survival rate (calculated value) was decreasing much more dramatically than ATS (observed value). It was estimated that this result would revealed that any other stressors than DLCs could affect fish population more strongly at low toxicity than at high toxicity.

We would decide thresholds (C1, C2) for long-term conservation of local fish populations like Fig. 7.

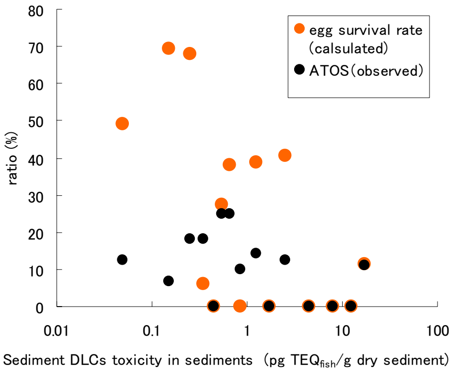


Fig.6 Comparison between egg survival rate calculated by toxicological approach and ATOS by nationwide research (rainbow trout)

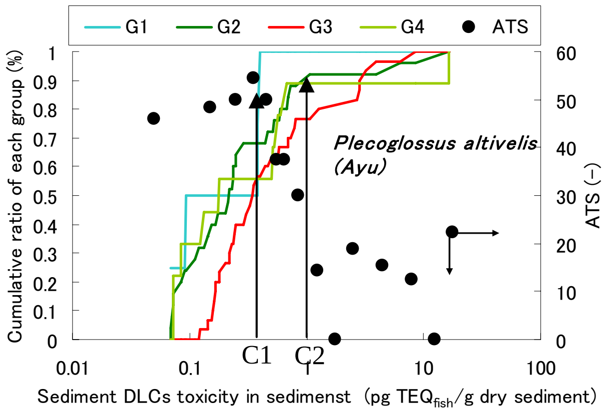


Fig.7 Application to thresholds estimation

If less than C1, little effects on population conservation by DCLs reduction strategy

If more than C2, genetic diversity within population has much decreased and local population is much

References

1. Cook PM, Robbins JA, Endicott DD, Lodge KB, Guiney PD, Walker MK, Zabel EW, Peterson RE. *Environ Sci Technol* 2003;37:3864.

2. Giesy JP, Jones PD, Kannan K, Newsted JL, Tillitt DE, Williams LL. Aquat Toxicol 2002;59:35.