SOCIO-ECONOMIC DRIVERS AND NON-INDIGENOUS FRESHWATER CRAYFISH SPECIES IN EUROPE

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SOCIOEKONOMSKI UZROCI I ALOHTONE VRSTE SLATKOVODNIH RAKOVA U EVROPI

Abstrakt

Strane vrste slatkovodnih rakova (NICS) prelaze po brojnosti autohtone u mnogim evropskim zemljama, predstavljajući pretnju biodiverzitetu zbog širenja "kuge" rakova, agresivne invazije i antagonističkog delovanja. Iako je biološka osnova ovog stanja dobro proučena, moguća uloga socijalnih, ekonomskih i demografskih činilaca za ovu situaciju je praktično ignorisana. U pokušaju da se ispitaju takvi odnosi, mi predlažemo da je gustina ljudske populacije i ekonomski rast meren kao rast domaćeg proizvoda (GDP) per capita pozitivno povezan sa povećanim brojem NICS-a u Evropskoj Uniji. Ovo je očigledno u zemljama sa većim ukupnim ekološkim tragom. U gornjem kontekstu hitno su potrebne akcije da se povrate/uravnoteže postojeće i projektovane ekološke promene prouzrokovane prisustvom NICS-a.

Ključne reči: biodiverzitet, demografski pritisci, ekološke promene, invazivne vrste rakova.

INTRODUCTION

Social forces are widely accepted as the dominant factor shaping natural environment (Moore, 2000). Accordingly, 'modernization' processes (e.g., economic growth, industrialization, urbanization and demographic pressures) are considered as critical to biodiversity, climate change and ecological health of the natural environment (Clausen & York, 2008). This is particularly true for aquatic environment where degradation is continuously documented (Kottelat & Freyhof, 2007). Only recently, the influences of economic growth have started to be examined against the possibilities of further widening existing ecological rifts in the aquatic environment (Clausen & Clark, 2005; Perdikaris & Paschos, 2011).

The populations of the five European indigenous crayfish species (ICS) once abundant were seriously devastated by 'crayfish plague' (Alderman, 1996). Moreover, pollution and eutrophication, overharvest, agro-chemical runoffs, alteration/destruction of natural habitats and water abstraction are the major anthropogenic pressures leading to the extirpation of populations and disjunctive distribution of the remaining ones (Koutrakis et al., 2007). These diversity losses are expected to develop further in the future, due to current spatial expansion and competitive advantages of the nine established non-indigenous crayfish species (NICS) in Europe. Moreover, the practically uncontrolled globalized aquarium trade of live ornamental NICS possesses additional threat to ICS (Chucholl, 2010). Therefore, economic incentives and human-generated impacts appear to determine significantly the future status of ICS in a Pan-European level.

The present work aims to examine possible relations and trends between demographic factors (human population density), economic factors (urbanization level, GDP *per capita*), ecological status (biocapacity/footprint) and the number of established NICS in the EU area.

MATERIALS AND METHODS

Data on the number of NICS present in 26 EU countries were supplied by Holdich et al. (2009). All data relevant to population density, urbanization percentage and GDP *per capita* came from the World Bank (2009). Finally, biocapacity and ecological footprint data were supplied by World Wide Fund (2008). The number of NICS was plotted against each one of the above independent variables and coefficient *r* of the best fitted curve was calculated in each case.

RESULTS & DISCUSSION

A. Demographic effects on the number of NICS

Human population density positively correlates (r=0.67) with the number of NICS (Figure 1). In fact, nine out of ten species introduced in European freshwaters have been successfully established (Holdich et al., 2009). Similar studies (Hoffman, 2004; Clausen & York, 2008) suggested that demographic factors are related to environmental degradation as the most densely populated nations have higher rates of threatened species and certainly more hobbyists possessing and culturing crayfish.

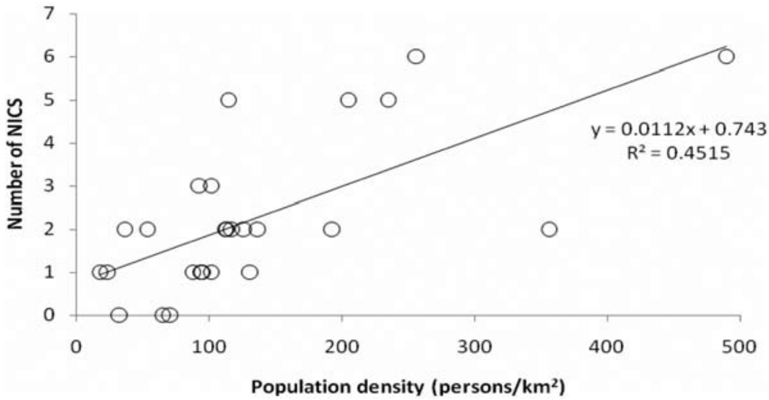

Figure 1. Graphic plot of the number of NICS against population density in the EU countries inhabited by freshwater crayfish (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Spain, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, United Kingdom)

B. Economic effects on the number of NICS

Urbanization level seems to have a moderate effect on the number of NICS in EU area (*r*=0.39) (Figure 2). It is a fact that cities especially close to airports and ports are the main entrance gates of international trade and also the biggest trading places themselves; however this does not necessarily imply that ornamental NICS released deliberately by urban citizens have more chances to survive compared for example to the escapees from a crayfish farm in the countryside (depending primarily on culture density, the number of stocked animals, the number of escapees and finally the species concerned).

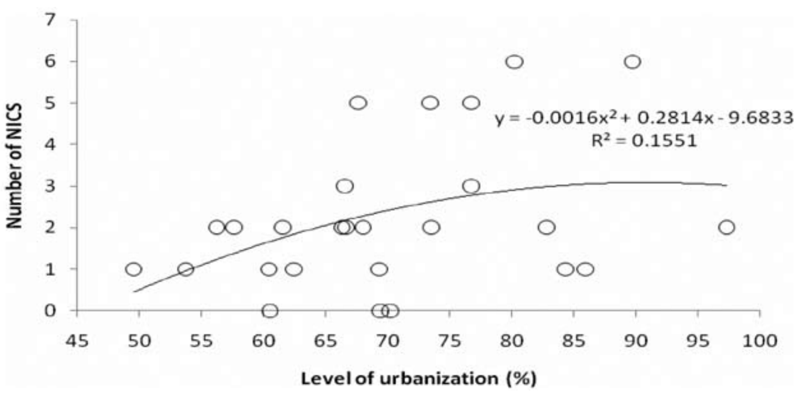

Figure 2. Graphic plot of the number of NICS against urbanization level in the EU countries inhabited by freshwater crayfish (countries as in Figure 1)

According to the neo-liberal theories, early stages of economic development goes parallel to environmental degradation, but eventually economic improvement (e.g., >$9000 measured as GDP *per capita*; Hoffman, 2004) leads to 'ecological rationalization' and amelioration of the impacts. In the case of NICS, there is a moderate tendency (r= 0.47) to gradually incease their numbers in the EU countries up to $40,000 GDP *per capita* before start falling (Figure 3). This picture suggests that economic growth contributes to the amplification of the pressures faced by the ICS in their habitats due to the increased numbers of NICS. Similar outcomes have been reported for the observed and expected decline of endangered species for developed nations (Czech et al., 2000; Naido & Adamowicz, 2001) and cross-nationally (Clausen & York, 2008).

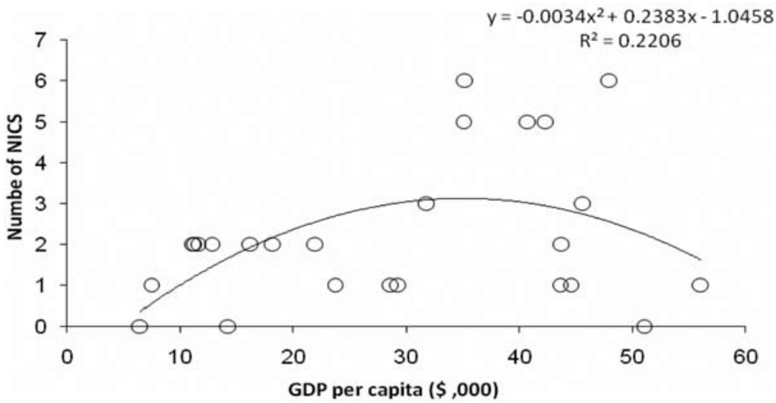

Figure 3. Graphic plot of the number of NICS against GDP *per capita* in the EU countries inhabited by freshwater crayfish (countries as in Figure 1 excluding Luxemburg)

C. Ecological status and NICS

Ecological footprinting tools revealed that European *per capita* ecological footprint during 2005 was about double compared to the available biocapacity (WWF, 2008). In this context, the number of NICS increases as we move from the ecological creditor to ecological debtor countries (r=0.45) (Figure 4). This trend can be either explained by the long history of trade dependency for natural resources in many European countries or the absence or weak enforcement of environmental protection, taking in account the risks generated for the ICS. Overall, the presence of NICS correlates well with unsustainable practices in resource management and implies possible ecological rifts generated in many production sectors.

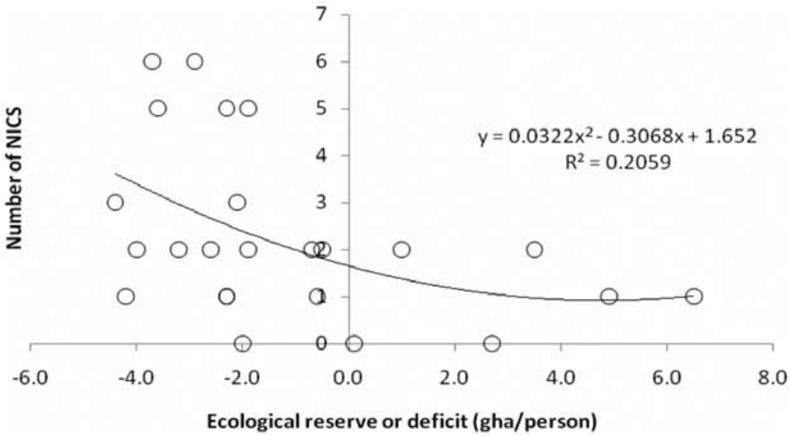

Figure 4. Graphic plot of the number of NICS against ecological reserve/deficit values in the EU countries inhabited by freshwater crayfish (countries as in Figure 1)

CONCLUSIONS

Managing the spread of NICS is not an easy task given the human-assisted introductions (Peay, 2009). It is obvious thus, that profit generation and accordingly strong lobby interests in aquarium trade is a major obstacle against the introduction and enforcement of legal instruments. Indirect metabolic (ecological) rifts are continuously created by the spread of NICS through direct impacts on ICS and other aquatic biota and structural modification of habitats (Nyström et al., 1996). EU legislative frameworks, recent actions to adopt strategies against alien species and the development of risk screening tools of NICS are expected to assist in some extent to the protection of ICS. Moreover, there is a need to address the fundamental causes of NICS spread in the EU territory in a more holistic way taking in account impacts generated by the social, demographic and the economic environment.

ACKNOWLEDGEMENTS
This study was partly supported by the grants No. CZ.1.05/2.1.00/01.0024 and 047/2010/Z.

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