

**ABSTRACTS for Posters**  
**at the**  
**4th International Symposium on Stock Enhancement and Sea Ranching.**

**1. VARIATION OF SOME BIOLOGICAL CHARACTERISTICS OF CASPIAN BROWN TROUT IN SOUTHERN CASPIAN SEA**

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The Caspian brown trout, *Salmo trutta caspius*, is one of the largest trout of the world, this species have been eliminated from much of their historic range in south of Caspian basin. In this study we evaluated the changes in size-at-maturity and fecundity of Caspian brown trout during last decades which may be helpful in conservation and management of this critically endangered taxon. The results show that the fecundity and size at maturity of Caspian brown trout has been decreasing in recent decades, we found a significant reduction in total length, weight and absolute fecundity between 1947 and 1986, but no significant differences were observed between these traits in 1986 and 2007. Also, no significant difference was observed in relative fecundity between samples collected in 1947 and 1973. The value of relative fecundity significantly decreased from 1973 to 1986 and then remained significantly unchanged up to 2007. We discussed about the main factors that may be responsible for change in biological characteristics such as temperature, over fishing, food availability and artificial reproduction.

Key words: Caspian Sea, *Salmo trutta*, conservation

**2. CONDITIONING IMPROVES SURVIVAL OF HATCHERY-REARED JUVENILE EUROPEAN LOBSTER (HOMARUS GAMMARUS)**

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Predation immediately after release has been regarded a major limitation with releases of European lobster (*Homarus gammarus*), whether for sea-ranching or restocking purposes. Lobster is traditionally reared individually, in single compartments deprived stimuli of substrate, shelter and interaction with con species, i.e. naïve (Fig 1a). A series of experiments were conducted to test if an enriched environment, i.e. conditioning, can improve performance and survival (Fig 1b). In the first set of experiments, 20 naïve and 20 conditioned juveniles of the same sizes were introduced into tanks (4 m<sup>2</sup>) with shell sand as substrate, and offered 20 shelters. The conditioning period had lasted from the settling stage IV until about 4 months of age. All the 40 individuals had to compete for the 20 shelters. The treatment groups were tagged with different colours of elastomer tags (Northwest Marine Technology), for later identification. After 12 days, all shelters were occupied by juveniles. Of those that had not found shelter, about 80% were from the single-compartment group. At the end of the experiment (3 months), about 88% of those that had found shelter had previously been conditioned.

In the second experiment, naïve juveniles were purchased from a commercial hatchery (Norwegian Lobster Farm AS). One group was conditioned for shell sand and shelter for 6 ½ week. The other

group continued in single compartments for the same period. The treatment groups were tagged with different colours of elastomer tags, for later identification. The juveniles were released in equal numbers into two enclosures (10 m<sup>2</sup>), placed on the bottom of a lobster holding park facility. The bottom of the enclosures consisted of shell sand and shelter (empty shells of scallop and oyster). After 9 months, from 66 to 75% of the surviving lobsters were those that had been conditioned prior to release. These data are the first to demonstrate that hatchery-reared lobster juveniles can be conditioned and we suggest that this may serve as a strategy to train hatchery-reared lobster prior to releases into the wild.



Figure 1. a) single-compartment and b) conditioned environment with shell sand and shelter (in this picture: empty scallops).

### 3. THREE STRATEGIES TO MINIMIZE GENETIC LOSSES IN ENHANCEMENT PROGRAMS

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The limited number of breeders kept in the hatcheries represents a cornerstone in managing stock enhancement and restocking programs. Most of the programs conducted on marine finfish use 50-200 specimens as broodstock. However, the differential contribution among them reduces the effective number of breeders ( $N_b$ ), leading to a reduction in the genetic variability. In this paper, we introduce three strategies adopted in two different black sea bream (*Acanthopagrus schlegelii*) broodstocks used for stock enhancement. The first mean involves increasing the number of breeders. Results obtained keeping different numbers of breeders were compared. Secondly, we evaluated the improvements achieved collecting the eggs at different timings. This strategy confirmed the differential contribution among parental fish and enabled identifying minor contributors. A simplified protocol to reduce egg collection and tedious rearing procedures is also presented. Hence, it can be a promising tool to increase  $N_b$ , minimize the undesired loss of genetic variability and improve offspring fitness. Finally, genetic relationships among breeders was assessed and compared to those of the offspring before and after the release (Fig. 1). The post-release sample was genetically closer to the broodstock that produced juveniles for stocking than to the native wild population. The posterior genetic analysis evidenced the close relationships among specimens. In summary, the adoption of these three strategies has shown promising results to minimize deleterious genetic effects in black sea bream and we encourage testing their usefulness in other species.

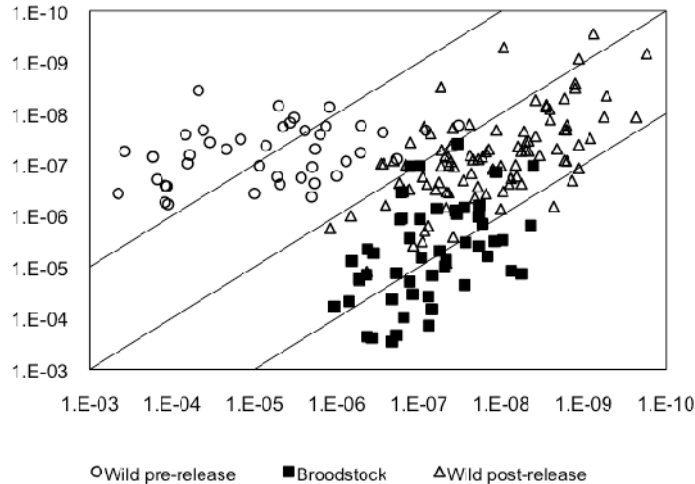


Fig. 1. Post-release black sea bream genotype probability for assignment to putative parental baselines (wild pre-release and broodstock) plotted on a log scale.

#### 4. HATCHERY-REARED JUVENILE SPOTTED SEATROUT, *CYNOSCION NEBULOSUS*, CAN LEARN TO FORAGE EFFECTIVELY ON LIVE NATURAL PREY

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The success of a responsible stock enhancement program is measured by the extent to which released fish contribute to the wild population. This requires, among other things, that hatchery-reared (HR) fish learn to forage as well as wild fish. The spotted seatrout (*Cynoscion nebulosus*) is the most popular recreational species in the Gulf of Mexico. To assess the feasibility of using stock enhancement as part of a comprehensive fisheries management strategy for spotted seatrout in Mississippi, the USM Gulf Coast Research Laboratory has been developing methods for the culture and release of juvenile spotted seatrout since 2006. Because HR juveniles are fed a pelleted diet, lack of experience with live prey could adversely affect their post-release survival.

To compare the feeding performance of wild and HR fish, the foraging cycle was characterized and quantified in terms of search time, prey recognition, capture success, and handling time. Individual HR and wild juvenile seatrout were exposed to live grass shrimp, *Palaemonetes* spp., a natural prey item, over a series of six trials. Video monitoring captured the interaction between fish and prey. One-way Repeated Measures ANOVA and Survival Analysis showed that wild fish performed more efficiently than HR fish. Wild fish successfully captured and consumed more shrimp over less time and with greater efficiency than HR fish. However, HR fish improved significantly across the trials particularly with respect to time to first prey recognition, strike efficiency, and time to first prey capture. Therefore, HR juvenile seatrout appear to possess the behavioral plasticity in foraging that could enable them to successfully transition to life in the wild.

## 5. COEXIST (INTERACTION IN COASTAL WATERS: A ROADMAP TO SUSTAINABLE INTEGRATION OF AQUACULTURE AND FISHERIES)

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Coastal areas are subject to ever increasing competition for space as a result of commercial and leisure activities and the desire to protect environmentally sensitive locations (for example, under Natura 2000). Small scale fisheries and aquaculture operations rely on access to appropriate sites but the extend of coastal waters available may be restricted due to the creation of Marine Protected Areas (MPA) or may also be of interest to other sectors such as tourism and offshore energy. This can lead to issues with spatial management of the coastal resource and can potentially lead to conflict between competing interests.

COEXIST is a broad, multidisciplinary approach to evaluate these interactions with the ultimate goal to provide a roadmap to better integration, sustainability and synergies among different activities in the coastal zone. The project brings together 13 partner institutions from 11 countries with expertise in both aquaculture and fisheries and coastal zone management. They will work together to assess the interactions between capture fisheries and aquaculture and other coastal users and evaluate the mutual benefits and potential sources of conflict. As part of the proposed research, Partners will look at operations at five case study areas, in the Atlantic, Adriatic and North Sea, and use the experience of local stakeholders, combined with the outcomes of existing international case studies, to evaluate the performance of current spatial management tools. This information will then be synthesised to produce guidelines for best practice in spatial planning for the fisheries and aquaculture industries with respect to other coastal interests for use by the EU Commission, national decision makers and in support of European maritime policy.

Project Partners	
Project Coordinator (Norway)	Institute of Marine Research (IMR), Bergen,
Denmark	Technical University of Denmark
Finland	Finnish Game and Fisheries Research Institute (FGFRI)
France	French Research Institute for Exploitation of the Sea (Ifremer)
Germany	Johann Heinrich Von Thuenen Institute - Federal Research Institute for Rural Areas, Forestry and Fisheries
Ireland	University College Cork – CMRC & AFDC Aqua TT UETP Ltd.
Italy	National Research Council
Netherlands	Agricultural Economics Research Institute (LEI Wageningen) Institute for Marine Resources and Ecosystem Studies (IMARES)
Portugal	National Institute of Biological Resources( INRB)Institute of Marine Research
United Kingdom	The Secretary of State for Environment, Food and Rural Affairs (DEFRA)
Sweden	National Board of Fisheries

## **6. GENETIC BASIS FOR RESPONSIBLE STOCK ENHANCEMENT AND OPTIMAL RELEASE STRATEGIES OF EASTERN KING PRAWNS (*PENAEUS MELICERTUS PLEBEJUS*)**

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Eastern king prawn (EKP) is an important commercial prawn species in Australia, distributed from northern Queensland to southern New South Wales. Assessment of the status and structure of this species may provide a basis for an ongoing stock enhancement program to increase and maintain population size of EKP in recruitment limited estuaries. Evaluation of the genetic impacts of releasing hatchery-reared post-larvae is essential for responsible large scale stock enhancement. This project aims to develop a genetic system for assessing the current stock structure, identifying the origin of recaptured prawns, and detecting genetic impacts of stock enhancement. The project will use two different types of genetic markers, microsatellites and mitochondrial DNA to assess the above objectives. Our preliminary data (mitochondrial DNA) shows that it is possible to track different female lineages through the stages of stock enhancement and the marker can also be used to quantify the contribution of different female broodstock. Furthermore, the developed markers will reveal the structure of the natural populations and differentiate between natural and hatchery-reared individuals. The outcome of this project will allow us to assess the impact of the releases and the interaction among wild and released animals, thereby providing valuable information for developing optimal release and management strategies for the fisheries.

## **7. EFFECTS OF SALINITY CHANGES ON IMMUNE PARAMETERS OF SCALLOP (*PATINOPECTEN YESSOENSIS*)**

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In this study, four immune parameters of scallop to salinity changes were investigated. The scallops were temporarily cultured at different salinity levels 40‰, 35‰, 30‰ for 7 days, and the activities of lysozyme (LZM), superoxide dismutase (SOD), catalase (CAT), glutathione (GSH) were recorded to evaluate the immune capacities to salinity changes (from 40‰ to 35‰, 35‰ to 30‰, 30‰ to 25‰, 30‰ to 35‰ in 5 days respectively). Result shows that the changing of 4 immune parameters were almost the same. LZM activities decreased significantly and then increased, finally remains above the control level; SOD activities significantly decreased and then increased to the control level; Activities of CAT decreased significantly and then increased, finally decreased to the control level; Activities of GSH increased significantly in a short time then increased significantly; finally decline to the control level; The above results demonstrated that salinity change could significantly affect the immune parameters of scallop.

Keywords: *Patinopecten yessoensis*; immune parameter; salinity; gradual change

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## 8. STUDIES ON THE CAPABILITY OF TOLERATING EXPOSURE AND DESICCATION AND LOW TEMPERATURE RESISTANCE OF SEA URCHIN *GLYPTOCIDARIS CRENULARIS*

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The effect of exposure and desiccation in different temperatures (0°C、5°C、8°C、10°C) and -1°C seawater on four scales(5-6mm、10mm、15mm、20mm) of sea urchin *Glyptocidaris crenularis* was investigated. The survival of different times (6h、12h、24h、48h in desiccation and 2h、4h、8h、12h、24h in -1°C seawater) was recorded respectively. The aim of this work is to supply guidelines for the transport of releasing and adaptability research of sea urchins. The result showed that, the sea urchin in test diameter of 5-6mm, the survival rate of 12h in exposure and desiccation was 80% at 10°C, but died all within 6h at 0°C and 5°C. The sea urchin of 10mm in test diameter was stronger than 5-6mm in the capability of tolerating exposure and desiccation. The survival rate of 24h was 80% at 10°C, but 0 within 6h at 0°C. The sea urchin of 15mm in test diameter was weaker than 10mm in the capability of tolerating exposure and desiccation. The survival rate of 24h was just 60% in 10°C, and died all within 12h at 0°C. The group of 20mm in test diameter was strongest. The survival rate of 48h was 100% at 10°C, and 0 within 12h at 0°C. The low temperature resistance of 5-6mm in test diameter was weakest at -1°C and the survival rate of 24h was just 40%. The sea urchin of 20mm in test diameter was strongest and the survival rate of 24h was 100% also. Consequently, It is best to select sea urchins of 20mm in test diameter and transport at 8°C. Also the sea urchin of 20mm in test diameter is strongest in the low temperature resistance.

**Keywords:** sea urchin; *Glyptocidaris crenularis*; tolerating exposure; desiccation; low temperature resistance

## 9. CURRENT SITUATION AND TREND OF ACOUSTIC TAMING IN MARINE RANCHING IN CHINA

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The development of marine ranching is an important research subject in fishery research field nowadays in China, it is now in starting stage, and has raised wide concern. Acoustic taming, as one of the most significant technology in the control of fish behaviour, is an effective means to realize the well construction and management of marine ranching. The study analysed the current position and deficiency of acoustic taming in China, pointing that fish behaviour and hydro-acoustics are the base of acoustic taming. The development of acoustic taming is based on tank experiment and the theory of underwater sound attenuation; Based on tank experiment, large outdoor experimental pond and marine environment were used, and do the experiment of tagging and releasing the fish, then the reckoning sound attenuation theoretical calculation was used in marine ranching. All of which contributed to a all-round assessment of marine ranching, making the management of marine ranching more scientific. Computer science and other related science subjects were also used to realize the remote administration of acoustic management by developing software.

**Key words:** marine ranching; acoustic taming; situation and trend; sound attenuation; China

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## 10. INDOOR AND DEEP SUBTIDAL INTERMEDIATE CULTURE OF *TROCHUS NILOTICUS* FOR RESTOCKING

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*Trochus niloticus* has long been successfully bred in captivity, but culturing of juveniles until ready for release remains a problem. Terrestrial plants have been used as food for wild trochus juveniles but their potential use in intermediate culture has not been evaluated. We conducted four growth trials for 60-120 days, rearing hatchery produced juveniles (10-28 mm diameter) at different stocking densities. Coconut leaves were used as the main or an additional substrate. Highest growth rates (3.93-4.63 mm·mo<sup>-1</sup>) were obtained in small cages (32-96 ind·m<sup>-2</sup>) deployed at 5-6 m on the reef slope. Trochus in wooden tanks at 2-8 ind·m<sup>-2</sup> grew by 2.01-2.72 mm·mo<sup>-1</sup>. Those in large cages (50-200 ind·m<sup>-2</sup>) on the reef slope grew by 0.79-1.95 mm·mo<sup>-1</sup>. There was a negligible growth of trochus in small cages in indoor tank. Growth declined with increasing size and density. Survival rates ranged between 92-99%. Incidence of escape in subtidal cages was low (0-5%) on the first 60 days, but increased to 22-28% on the 90<sup>th</sup> day due to typhoon. Recovery rates were not significantly different among treatments per growth trial. The results indicate that trochus juveniles can be successfully cultured at high density in subtidal cages with coconut leaves as substrate, and these are easier to handle than the more commonly used coral rocks.

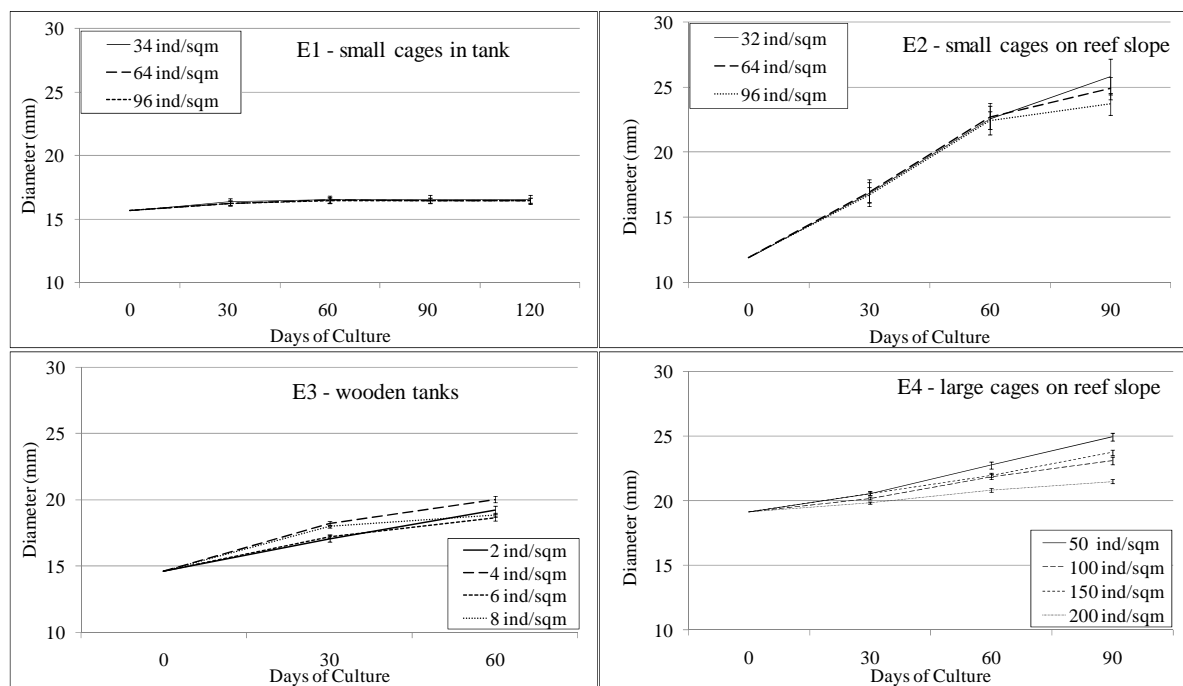


Figure 1. Monthly growth rates of *T. niloticus* per treatment per growth experiment.

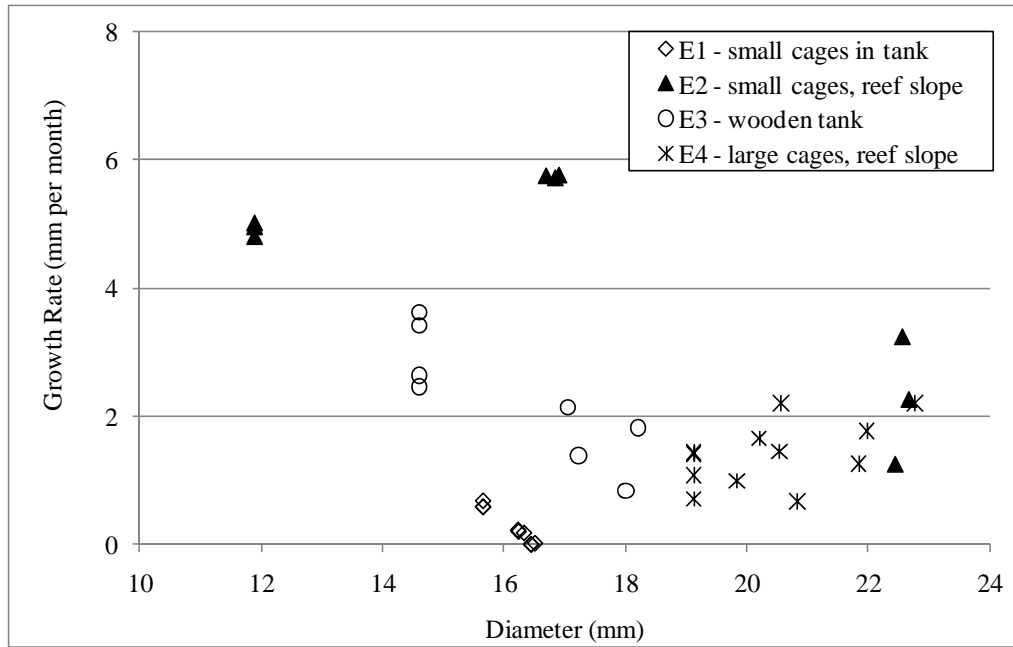


Figure 2. Growth rates ( $\text{mm}\cdot\text{mo}^{-1}$ ) of *T. niloticus* per sampling event per growth trial.

Table 1. Mean diameter and mean recovery rates (RR) at the end of each study. (T– treatment; Means- from three replicates for E1 & E2 and two replicates from E3 & E4; Age – is at the start of the study; Similar superscripts per experiment were not significant)

Expt. # (Replications)	DOC (days)	T	Age of shells (mo)	Density		Mean Diameter (mm)	Mean RR
				ind. per cage or tank	ind. $\text{m}^{-2}$		
E1 (3)	120	1	5	2	32	16.54 <sup>a</sup>	100.00
		2		4	64	16.41 <sup>a</sup>	95.83
		3		6	96	16.46 <sup>a</sup>	97.22
E2 (3)	90	1	12	2	32	25.92 <sup>a</sup>	88.89
		2		4	64	24.92 <sup>ab</sup>	83.33
		3		6	96	23.68 <sup>b</sup>	83.33
E3 (2)	60	1	10	50	2	19.20 <sup>b</sup>	99.00
		2		100	4	20.04 <sup>a</sup>	98.50
		3		150	6	18.62 <sup>b</sup>	96.17
E4 (2)	90	1	12	50	50	24.97 <sup>a</sup>	98.00
		2		100	100	23.10 <sup>b</sup>	80.83
		3		150	150	23.74 <sup>c</sup>	74.00
		4		200	200	21.50 <sup>d</sup>	90.42

## 11. THREATENED FISHES OF THE WORLD: SCHIZOTHORAX ZARUDNYI NIKOLSKII, 1897

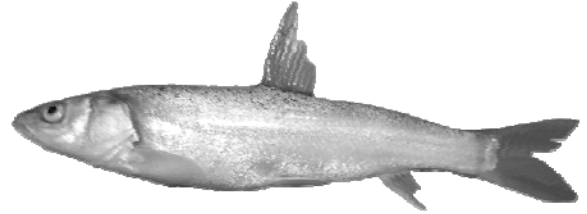
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**Common name:** (English name: Snow Trout, Persian name: Anjac, Hamun Mahi, Mahi Khaju, Shir Mahi & local name: white fish pronounced sefidak). **Conservation status:** Endangered (Ghanbari et al., 2009a, Zabihi, 2006).

**Identification:** Body is cylindrical, dorsally blackish and lateral side is pale yellow in colour. Biometric details are: Depth 5.3-20.2% of SL, Dorsal spines(total): 4 - 4; Dorsal soft rays (total): 8; Anal spines: 2; Anal soft rays: 5. The breast is naked or sparsely scaled. There is a pelvic axillary process. The scale sheath around the anal papilla and anal fin extends about one third to half way between the anal fin origin and the pelvic fin base. Scales are very small, horizontally ovoid and have an almost central focus. Scales are obliquely inserted in the scale pockets on the mid-flank above the lateral line and below the dorsal fin. Scales on the nape are none to minimally imbricate. Radii are found on all fields and are numerous. Gill rakers are long, reaching the third to the sixth adjacent raker when appressed. The interior margin of each raker is serrated. Pharyngeal teeth usually 2,3,5-5,3,2, spoon-shaped with a slightly hooked tip. Anterior teeth are more rounded and thicker. There are 2 pairs of barbels, the anterior ones long to rudimentary in literature sources. The barbels are subequal in length, the anterior ones not reaching the eye and the posterior ones not reaching beyond the eye. The mouth is usually slightly subterminal but can be terminal or have the lower jaw projecting slightly. The gut is elongate and coiled (Coad, 2002). The chromosome number is  $2n=96$ ,  $NF=142$ , comprising 9 pairs of metacentric, 14 pairs of submetacentric and 25 pairs of acrocentric chromosomes, and the fish is a tetraploid (Hosseini and Kalbasi, 2003; Kalbasi et al., 2008). **Distribution:** This fish is native of Sistan zone and its settlement was in Hamun Lake, but this lake became dry because of the drought in the field. Now, we can see this fish only in Chah-nimeh reservoirs (61°36'–61°43'N, 30°45'–30°50'E,) (Ghanbari et al., 2009b, Zabihi, 2006, Coad, 2002). Chahnimeh reservoirs occupy an area of 4.700 ha and 680 million cubic meter capacity. They are composed of three sub sectors 1(21 km<sup>2</sup>), 2(9 km<sup>2</sup>), and 3(17 km<sup>2</sup>) connected together by a system of channels. There is no continuous source of water supply into the reservoirs. The main source of water is Hirmand River which, unfortunately, is often dry. **Abundance:** The snow trout population size is poorly studied and there is no population estimate. Accounted for 60% of total harvest before the drought in the Hamun Wetland but now is rarely found (Ghanbari et al., 2009a). **Habitat and ecology:** Found in the open lake, in reed beds and in pools in Sistan. It is the only species in Sistan common in the open lake in winter. Young probably make their way up upstream in the flood season as only adults are found in the lake in winter. The species is extremely abundant in pools left in stream beds when the floods recede. Spawning may occur in rivers as fry have not been found in the lakes (Coad, 2002). Zabihi (2006) characterises it as a potamodromous species and notes that in March and April, if there is no flow in the rivers and thus no migration from the lake is possible, female gonads are reabsorbed. **Reproduction:** Mature specimens migrate during April-May from rivers and lakes to cold and well oxygenated waters (Streams and their tributaries) to breed in shallow pools within boulders, sand and gravel. The breeders after laying eggs migrate back to rivers and lakes leaving their young ones behind. The fertilized eggs are adhesive in nature and normally stick to sand, gravel or other substrate so that they are saved from being washed away by strong currents, floods etc. During the breeding season the species exhibit definite secondary sexual characters. Females are characterized by possessing soft, enlarged and distended belly whiles, while males develop prominent nuptial tubercles on the snout coupled with roughness of the body. The roughness of the body and the tubercles becomes evident just before spawning season and disappear shortly after the spawning. Males normally mature about a month earlier than females



under almost identical ecological condition (Ghanbari et al., 2009a). **Threats:** Propagation of the said species in nature has been drastically effected. Recruitment is not to the level of maintaining its population. The fish catch has shown declined trend (Ghanbari et al., 2009a,b). Overfishing is a potential cause of population declines and a serious complicating factor for conservation. **Conservation action:** SHILAT, according to the Government sector priorities, is taking up a priority to save this species before it gets extinct from natural water bodies. Experimental trials on artificial breeding and rearing of the species have been conducted by several research institutes in Iran. **Conservation recommendation:** Some form of legal protection should be instituted, education of local people initiated, captive breeding undertaken. Research for population preservation and restoration is required. Natural habitats should be protected.

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## 12. ISOLATION AND CHARACTERIZATION OF *LACTOBACILLUS* SPECIES FROM INTESTINAL CONTENTS OF CASPIAN SEA STURGEON

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Lactic acid bacteria are gram-positive, non-sporulating and catalase negative rods or cocci that ferment various carbohydrates mainly to lactate and acetate. Most of the evidences come from salmonid species There are no reports on the presence of *Lactobacillus* in the intestines of sturgeon fish inhabiting Caspian sea The aim of the present work was to make a survey on the presence of lactobacilli in the intestinal content of beluga (*Huso huso*) and Persian sturgeon (*Acipenser persicus*), two high marketing values species of Caspian sea sturgeon fish.

After dissecting the fish, 1 g of the intestinal tract content of each fish was removed under aseptic condition and placed into previously weighed flasks containing storage medium.. Afterwards serial dilutions were spread on plates of selective media and incubated at the appropriate conditions. Eighty four strains were randomly selected for identification procedures based on the phenotypical characteristics. Counts of intestinal lactobacilli for Persian sturgeon and beluga were detected at the

range of approximately  $10^{5.3}$  to  $10^{6.4}$  cfu/g, respectively ( Table 1, Table 2). The physiological and biochemical characterization of *Lactobacillus* isolates and the presumptive *Lactobacillus* species found in two fish species are shown in Table 2. From 84 isolates, 2 metabolic groups of *Lactobacillus* were recovered: facultative and obligate heterofermentatives. *L. sakei* and *L. plantarum* were the most often found isolates.

Knowledge on the presence of *Lactobacillus* as a natural flora in fish may lead to further applications to improve fish health. Consequently, the discovered lactobacilli in this study can be candidates as probiotic bacteria. They should resist processing and storage conditions and be alive and active even after gastrointestinal passage.

Table 1: Average bacterial counts of intestinal bacteria (Log cfu/g of intestinal content) for Persian sturgeon and beluga in different media

Fish species	No.	CAB (cfu/g)	LAMVAB (cfu/g)	MRS 4.2 (cfu/g)
<i>Acipenser persicus</i>	12	7.84	5.32	4.85
<i>Huso huso</i>	10	8.21	6.45	5.64

CAB: Columbia blood agar; LAMVAB: *Lactobacillus* spp. Anaerobic MRS with Vancomycin and Bromocresol green; MRS 4.2: deMan, Rogosa and Sharp

Table 2: *Lactobacillus* species isolated from the intestines of sturgeon fish

Presumptive <i>Lactobacillus</i> species	<i>L.</i> <i>sakei</i>	<i>L.</i> <i>plantarum</i>	<i>L.</i> <i>coryneformis</i>	<i>L.</i> <i>alimentarius</i>	<i>L.</i> <i>brevis</i>	<i>L.</i> <i>casei</i>	<i>L. oris</i>
<i>Acipenser persicus</i>	**	**	*	**	-	**	*
<i>Huso huso</i>	**	*	-	*	**	*	*

\* = Presence of lactobacilli. \*\* = High number of lactobacilli presence

### 13. TRANSLOCATION OF LOBSTERS RESULTS IN DENSITY DEPENDENT CHANGES TO GROWTH

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Demographic and market traits of the southern rock lobster, *Jasus edwardsii*, vary throughout its' range, which affects the distribution and production of the fishing industry. Lobsters from deep water tend to be pale (and thus lower value), have slower growth and higher density. We undertook a large-scale experiment to explore whether the yield and value of these deep water lobsters could be increased by translocating individuals to faster growth, shallow habitat. Over 3 years, approximately 30000 lobsters were captured from a southern, deep water site, Maatsuyker Island, and translocated in lots of 1800 to 2000 individuals to 8 inshore shallow water sites along the east coast of Tasmania, ranging from 30 to 300nm from the capture site. Growth of residents at the removal site and the Taroona release site was measured before and after the translocation. Growth at the removal site increased while growth at the release site decreased after 6000 lobsters were introduced, a pattern consistent with density-dependent suppression of growth. These results enable better prediction of the effect of large scale enhancement / translocation programs on productivity. Further, the removal of large numbers of lobsters from the source site is mimicking the effects of fishing and change in productivity that may result.

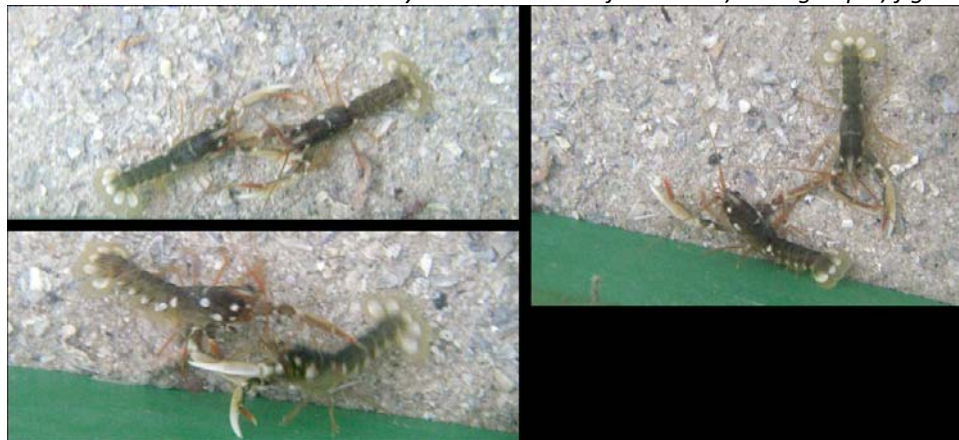
#### 14. BEHAVIOUR IN HATCHERY REARED EUROPEAN LOBSTER (*HOMARUS GAMMARUS*) JUVENILES AFTER RELEASE; THE GOOD AND THE BAD

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Hatchery-reared lobster juveniles (*Homarus gammarus*) construct burrows and seek shelter when given the opportunity. However, in situ observations have shown that predators like crabs and wrasse prey upon recently released hatchery-reared lobster juveniles. Reduced ability to find and seek shelter in hatchery-reared juveniles may explain why they are highly susceptible to predation when released in the wild. Recent studies have shown that conditioning (i.e. exposing the juveniles to a habitat consisting of shell-sand and shelter for a period of several weeks) the juveniles upon release lead to increased survival rate. In this paper we explore behaviour in lobster juveniles, comparing single-compartment production with conditioned juveniles. The main goal was to assess if it is possible to differentiate "good" from "bad", in order to avoid the "ugly" situation of feeding frenzies at the release site.

We have focused on sinking time, shelter-seeking behaviour and social interactions in lobster juveniles of 10-12 mm carapace length. The results indicate that single-compartment produced lobsters tend to spend more time in the water column compared to conditioned juveniles, but this varies with size. Also, sinking behaviour was recorded and characterized. A pilot study was conducted to study shelter-seeking behaviour and social interactions (Figure 1). There was a clear tendency for the single compartment produced juveniles to crawl on the side of the experimental tank, thus spending less time searching for shelter. Such behaviour is not optimal in a release situation, exposing the juveniles to a number of potential predators. When competing for shelter, in 54 % of the trials the conditioned juveniles were established under shelter within 30 minutes after release. In 12.5 % of the trials the single-compartment juveniles managed to establish and in 33.5 % of the trials none of the juveniles were established. These preliminary results clearly indicate that conditioning seems to change behaviour in lobster juveniles, increasing the ability to compete for shelter. More experiments are needed to look not only into shelter-seeking behaviour but also predator-prey interactions.

*Figure 1. Social interaction between recently released lobster juveniles a) claw grasp b) fighting c)*



*retreat.*

## 15. CATCH FLUCTUATION OF KURUMA PRAWNS IN JAPAN IN RELATION TO STOCK ENHANCEMENT PROGRAMS AND CLIMATE CHANGE

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Kuruma prawns, *Penaeus japonicus*, are widely distributed in the Indo-West Pacific. In Japan, they occur throughout the country, except in Hokkaido, and are one of the most important crustaceans contributing to fisheries and aquaculture. The stock enhancement program through production and release of juveniles into the natural habitat for kuruma prawns started in the Seto Inland Sea (SIS) in 1964 and expanded throughout the country. Local, fisher-based statistics became available for production of kuruma prawns in 1965 (Fig. 1). Between 1965 and 1970, national annual landings decreased from 2,915 to 1,263 t. Catches recovered to a record of 3,741 t in 1985, but then declined steadily to a historical minimum of 726 t in 2008. Thus, kuruma prawn catches have fluctuated greatly. In this presentation, we analyze the catch fluctuation of kuruma prawns in Japan in relation to stock enhancement programs and climate change.

Release statistics are available from 1977. The annual number of juveniles released throughout Japan ranged from ~240 to 300 million until the mid-1990s, but then decreased steadily to ~105 million in 2008 (Fig. 1). Conversely, the body length of released juveniles increased from ~20 mm in the 1970s to ~35 mm in recent years. It appears that the annual production of kuruma prawns largely decreased according to a decline of juvenile releases in recent years.

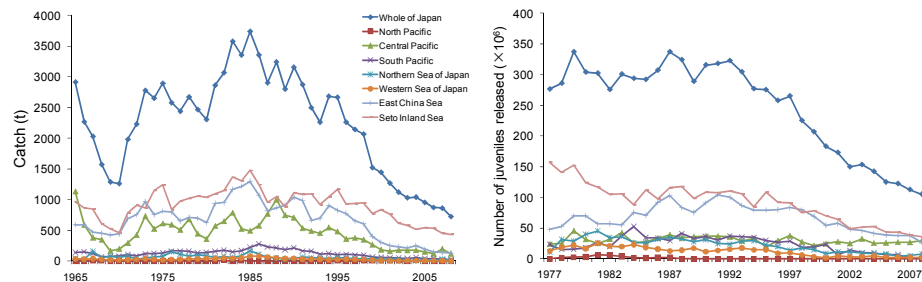


Fig. 1. Changes in the annual catch and number of juvenile kuruma prawns released in the whole of Japan and the seven regional seas.

The reproductive season of kuruma prawns extends from spring to autumn. The juveniles, 7–9 mm body length (BL), settle on tidal flats after a planktonic larval stage of one month. The juveniles remain in the intertidal zone for ~2–10 months before migrating to deeper waters at a size of ~100 mm BL. Males and females reach maturity at 100 mm and 125 mm BL, respectively, about one year after settlement. The life span is considered to be 2–3 years. The prawns recruit to the fishing grounds after migrating from the tidal flats to deeper waters and are caught using several types of fishing gear, such as gill nets, set nets and small beam trawls, mainly throughout the following year (1+ age). Therefore, to elucidate the effect of juvenile releases on kuruma prawn production, we plotted the annual catch in the year  $t_i$  against the mean number of juveniles released in the year  $t_{i-1}$  and  $t_i$  in regional seas excluding the North Pacific where kuruma prawn catches have been very small (Fig. 2). These relationships illustrate that the annual production tended to increase with an increasing magnitude of releases; however, catch data were highly variable.

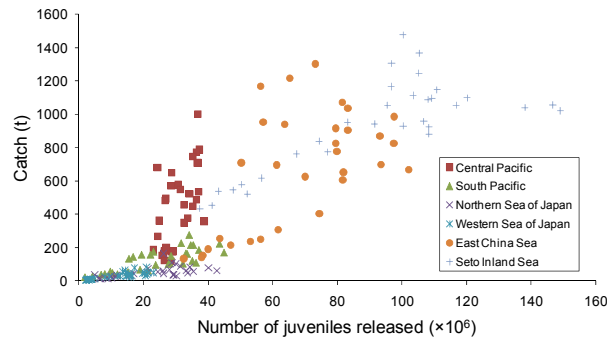


Fig. 2. Relationship between the numbers of juveniles released and the catch of kuruma prawns.

Although catches of kuruma prawns have been greatest in regional seas with relatively extensive tidal flats, such as the Central Pacific (CP), East China Sea (ECS) and SIS, they have fluctuated similarly in each regional sea (Fig. 1), suggesting that common environmental factors have affected the abundance of kuruma prawn stocks in Japan. Two major warm ocean currents flow around the Japanese Archipelago, i.e., the Kuroshio (KU) from west southern Kyushu to middle Honshu, and the Tsushima warm current (TWC), which is derived from the KU, from west southern Kyushu to the coast around the Sea of Japan. It is known that these ocean currents have affected fishery resources through changing ocean climate. Analysis of the relationships between anomalies of KU and TWC intensity indices and kuruma prawn catches showed that annual landings of kuruma prawns tended to decrease when the KU moved northward, and when the intensity of the TWC was strong. This indicates that ocean current intensity indices should be included as explanatory variables that can affect catch fluctuations of kuruma prawns.

We applied the multiple linear regression model (LM) and linear mixed-effects model (LMM) to assess the relationships between annual catches of kuruma prawns (response variable), and the mean number of juveniles released in regional seas and the mean index of TWC intensity (explanatory variables) in the years  $t_{i-1}$  and  $t_i$ , which had higher correlation coefficients with catch data than the KU. The intensity index for TWC is an anomaly of the area  $\geq 10$  °C at 100 m depth in the Sea of Japan (data from Japan Metrological Agency). In some regional seas, catches declined greatly after 1999, so that the data were separated before and after 1999 (periods 1 and 2, respectively), and the periods were set for random intercepts in the LMM. In the linear models, the intercept can be considered as basic production of kuruma prawns and the coefficient for number of juveniles released is equivalent to the yield per released juvenile. The LM and LMM revealed that the annual landings of kuruma prawns were positively and negatively correlated with juvenile releases and TWC intensity, respectively. Furthermore, basic production of kuruma prawns decreased after 1999 in the CP, South Pacific, ECS and SIS.

Our analysis highlighted that juvenile releases could augment the kuruma prawn catches when stocks fluctuated with ocean climate change. Regime shift and decreased magnitude of releases could be responsible for recent catch decline of kuruma prawns in Japanese waters.

## 16. STOCK ENHANCEMENT IN GREENLIP ABALONE: LONG-TERM GROWTH AND SURVIVAL

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A cohort of greenlip abalone (*Haliotis laevis*), spawned from wild broodstock, was monitored from birth until recruitment into the fishery (Age 6+). The targeted enhancement size-class was  $\geq 140$  mm shell length, and animals were released at age 18 months ( $31 \text{ mm} \pm 4 \text{ SD}$ ). Release densities were tailored to match wild-stock densities using a size-dependent mortality model. A total of 8800 animals were released into 28 sites, and each site was precisely mapped to control release densities. Environmental and husbandry factors were also quantified. Initial survival rates (6 months post release) differed significantly among sites (range: 11% – 67%), but not beyond this. Legal minimum length (140 mm) was achieved, on average, at 5 years of age or 3.5 years post release, and there was clear evidence of fishing mortality on the seeded cohort by Age 6+. Cumulative survival at Age 5 varied between 20% at the best sites, and 6% at the worst sites, with an average of 13%. Water depth was significantly positively correlated with growth ( $r = 0.47$ ;  $p < 0.05$ ), but no other ecological variables influenced growth or survival. Husbandry factors were implicated in sites with poor survival, but this was not confirmed statistically.

## 17. HABITAT ENHANCEMENT OF MARINE ECOSYSTEMS: TRANSPLANTING EELGRASS ON THE SOUTH COAST OF KOREA

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Seagrass meadows play an important role in the coastal ecosystem. However, seagrass beds have declined dramatically over the last few decades worldwide due to anthropogenic and natural causes. Seagrass transplantation has been considered an effective method to mitigate seagrass degradation and restore damaged seagrass beds. As the most widespread seagrass species in temperate waters of the Northern Hemisphere, eelgrass (*Zostera marina* L.) and its restoration have received great attention in many countries. To determine the suitable seasons for eelgrass transplanting in Korea, transplantation experiments were conducted in the summer, fall, winter of 2008 and spring of 2009 in Jindong Bay on the south coast of Korea. The survival of transplants and the physiology, morphology and growth of both transplants and control plants were investigated monthly for about 3 months after transplantation. Results indicated that the shoot density of transplants increased in the fall, winter and spring transplantations, but decreased greatly in the summer. Chlorophyll content was significantly reduced in the initial period after transplantation in summer and winter, but increased significantly in fall. Shoot height was significantly reduced in the four seasons during the initial period, but in fall, it increased to a comparable level to that of control plants. Leaf biomass per shoot was significantly reduced in summer, winter and spring, but not in fall. Rhizome diameter was reduced in summer and winter, but increased in fall. Rhizome biomass was also reduced in summer and winter, but increased in fall. Leaf production was significantly reduced in the four seasons during the initial period after transplantation, but became comparable to those of control plants in fall and winter. Below-ground biomass per shoot was significantly reduced in summer and winter, but not in fall and spring. The results indicated that eelgrass reproduction, physiology, morphology and growth were significantly influenced by water temperature. As far as the survival and growth of transplants are concerned, the suitable seasons for eelgrass transplantation in Korea are fall, winter and spring (in order of priority).

## 18. COMPARISON OF THE CAPTURE COMPOSITION IN NORTHWEST PACIFIC OCEAN IN DIFFERENT YEARS

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Based on the samples from Chinese squid jigging vessels in the area of Northwest Pacific in 2007 and 2009, the annual biological characteristics of squid *Omneaslrephes bartrami* were studied and compared. The results showed that average mantle length of male was smaller than female's, the dominant group were 230-320mm and 200-320mm in male and female respectively, and the proportion of large individuals in 2009 was smaller than 2007. The sex ratio of female to male was nearly to 1:1. There were significant difference of relationship between mantle length and body weight in different sexes and years ( $P < 0.001$ ). The squid maturity stage had no distinct difference between the two years, and dominant stage was  $\text{II}$  and  $\text{III}$ . Sex maturation of females was later than males and the proportion of matured individuals in 2007 was higher than 2009 both in male and female. The length and weight of ink gland of the squid were increased with development of the gland. The mantle length of first maturity were 337.02mm and 303.01mm for female and male respectively in 2007, while in 2009, the mantle length of first maturity for female was 350-380mm which is similar to that of 2007, and that for male was less than 200mm, which is smaller than that of 2007. In conclusion, there were two cohorts in 2007 and 2009 in Northwest Pacific Ocean, Small population (S) and large population (L); there was an unusual cold water to south in the deep water of Northwest Pacific Ocean lead to the difference with 2007 in cohort.

**Keywords:** *Omneaslrephes bartrami*; Northwest Pacific Ocean; biological characteristics; inter-annual variations

## 19. WHITEFISH WARS: WHO WILL WIN AND WHY IT MATTERS

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The recent media coverage of pangasius imports into Europe reflect an increasing acrimonious debate around the trade-offs of protecting European livelihoods based on fisheries and aquaculture and meeting consumers' needs. This dialogue is analysed from the positions adopted by various stakeholders and framed in a rapidly changing environment in terms of purchasing power and trends in global trade. Claims aiming to denigrate the product in terms of its environmental and social credentials are assessed and the emerging roles of certification and certifying organisations critiqued. The longer term negative consequences of this trade disputes are considered.

## 20. RESEARCH ON MODEL EXPERIMENTS OF THE HYDRAULIC RESISTANCE COEFFICIENT OF ARTIFICIAL REEFS

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The hydraulic resistance coefficient of artificial reefs (AR) under different angles have been studied through wind tunnel experiments, in order to make the quantitative analysis between the resistance coefficient and the opening ratio of the reef on different types of centre opening (circular, triangle, rectangle). The experiment results show that (1) the principal factor of influence is the penetrating opening rate, projection opening rate and the angle of attack, the value of  $C_d$  is decreasing with increase of penetrating opening rate ( $\gamma_{tt}$ ); (2) the formula of the resistance coefficient is  $C_d = -0.861\gamma_{tt} + 0.145\gamma_{ty} + 1.268$  ( $R_2 = 0.729$ ,  $P < 0.01$ ) on different types of opening. We can design a new artificial reef with a good hydrodynamic characteristic by means of the adjusting of the opening rate.

**Key words:** artificial reef; hydraulic resistance; model test; wind tunnel

## 21. ECOLOGICAL INTERACTIONS BETWEEN HATCHERY AND WILD FISH: A CASE STUDY OF THE STRONGLY PISCIVOROUS JAPANESE SPANISH MACKEREL

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A surplus carrying capacity is indispensable to augmenting fisheries production by release of hatchery-reared animals. If juveniles are released beyond the carrying capacity, a reduction in the growth rate of wild fish could occur, or in extreme cases, hatchery fish might replace wild fish due to competition for prey between hatchery and wild fish or cannibalism. However, evidence supporting such ecological impacts has so far been sparse. Top predator fish species would clearly show the impacts if this actually occurred under a limited carrying capacity. Here, we investigated the ecological interaction between hatchery and wild fish using data for Japanese Spanish mackerel (JSM), *Scomberomorus niphonius*, in the Seto Inland Sea (SIS).

JSM is a large piscivorous fish, mainly distributed off the western coast of Japan. This species is an important fishery resource, especially in the SIS. Larval and juvenile fish are piscivorous and grow very rapidly. Figure 1 shows the annual catch and release statistics of JSM in the SIS. To recover the decreased commercial catch of this species, the National Center for Stock Enhancement initiated a stocking programme in

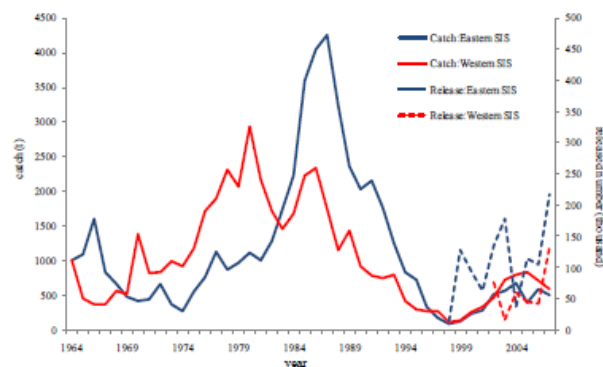


Fig. 1 Annual catch of the Japanese Spanish Mackerel and the number of released fish in the SIS (1964-2007).

1998. A total of 1,080,146 and 371,715 hatchery-reared juveniles have been released in the eastern SIS from 1998 and the western SIS from 2002, respectively. The contribution of hatchery fish to the total catch in the eastern SIS was estimated at 6.1% and 30.8% for the 2002 and 2003 releases, respectively.

Large variations in the catch of prey fish, *Engraulis japonicus* and *Ammodytes personatus*, explained well the catch history of JSM in the eastern SIS, suggesting that the population dynamics of JSM depends on their prey dynamics, which should define the carrying capacity of JSM. The annual catch of newly recruited JSM (0+ age) was negatively correlated with its average weight. The average weight increased until 1995 but turned to decrease in 1996 with variation. In the eastern SIS, the number of released fish was negatively correlated with the average weight of 0+ age wild fish, suggesting that JSM used the limited carrying capacity to the full in this area and the releases affected the growth of wild fish. The size distribution of the 0+ age fish sampled showed that released fish were larger than wild fish. We also estimated the size and individual ages (days) of JSM cannibalized by released fish on the basis of standard length, mouth diameter of fish at release. The possibility of replacement of wild fish by hatchery fish due to cannibalism is discussed on the basis of catch and release statistics and the result of the simulation given in the companion paper by Obata et al., which will be presented in the poster session.

## **22. COMPARATIVE DISTRIBUTION OF PSP TOXINS IN VARIOUS TISSUES OF PEN SHELL *ATRINA PECTINATA* EXPOSED TO BLOOM OF TOXIC RED TIDE**

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Pen shell *Atrina pectinata* is one of the commercially important bivalves in Asia-Pacific region. In the Philippines, it is marketed as a whole meat or processed by shellfish harvesters to separate the adductor muscle as an export commodity. During blooms of toxic dinoflagellate *Pyrodinium bahamense* var. *compressum* (Pbc), *A. pectinata* accumulates paralytic shellfish poisoning (PSP) toxins sometimes exceeding Philippine regulatory limit of 60µgSTXeq/100g tissue and international regulatory limit of 80µgSTXeq/100g tissue for safe human consumption, based on whole tissue analysis. Toxic blooms directly affect the shellfish industry which includes *A. pectinata*, and this causes not only significant economical losses on shellfish gatherers but also serious public health concerns. In this study, samples of *A. pectinata* exposed to toxic bloom of Pbc were collected in Sorsogon Bay, Philippines. Bioaccumulation and distribution of PSP toxins were determined in different tissues namely, adductor muscle, mantle, gills, gonads, siphon, stomach and intestine using High Performance Liquid Chromatography post column derivatization method with fluorescence detection. Likewise, green mussels being the sentinel species for PSP monitoring in the Philippines were also collected in the same area and served as control. Interestingly, results showed that adductor muscle accumulates minimal level of PSP toxins and is several folds lower than the Philippine and international regulatory limits in contrast with the results obtained from green mussels. Mantle parts showed toxicity values exceeding local regulatory limit and near to go beyond the international regulatory limit. On the other hand, the remaining parts showed high toxicity values surpassing both regulation limits. Subsequently, standard mouse bioassay regularly used in PSP monitoring in the Philippines was also performed and revealed that the adductor muscle had non-detectable level of toxins. Toxicity values from different tissues and shellfish body lengths or age were also assessed and were found to be uncorrelated. Noteworthy, STX was the only toxin

detected in the adductor muscle suggesting a bioconversion of all other toxin derivatives. Most importantly, adductor muscle of *A. pectinata* accumulates minimal toxicity level, thus removal of this part from the whole body for marketing suggests safe human consumption despite toxic red tide bloom, provided with strict quality assurance application on the said product.

*Keywords:* *Atrina pectinata*; Adductor Muscle; Paralytic Shellfish Poisoning Toxins

### **23. STUDY OF THE SEASON, TIME APPEARS THE EEL FINGERLINGS IN QUANG BINH PROVINCE**

**Nguyen Quang Linh**, Tran Dinh Minh, Nguyen Duc Thanh, Ho Viet Lam, Nguyen Duy Quynh Tram, Ha Thi Hue

Grass eels immigrate from the sea through estuaries of Central Vietnam from May 9 to 11 in the North Central Province. In Quang Binh, eels immigrated mainly through the Nhat Le and Gianh estuaries. The results show that the grass eels immigrated mainly on the dark nights from 20th to the 30th of month, when salinities were around 15 – 18%. Eels were collected under dams or dykes that were located where bars can stop the immigration of eels. Different sizes of eels were collected, ranging from 0.11 g to 0.50g/head. Grass eels can immigrate in large groups and mainly at night (20:00 to 22:00 h) or the early morning (0300 to 0500 h), water temperatures were 22 to 25°C.

### **24. A SIMULATION MODEL TO EVALUATE FISHERY STOCK ENHANCEMENT AND MANAGEMENT STRATEGY: A CASE STUDY OF JAPANESE SPANISH MACKEREL IN THE EASTERN SETO INLAND SEA**

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Japanese Spanish mackerel (JSM), *Scomberomorus niphonius*, is a large migratory fish that feeds on small fish and is mainly distributed off the western coast of Japan. The species is an important fishery resource, especially in the Seto Inland Sea (SIS), with the fishery targeting adult fish migrating into the spawning grounds from the Kii Channel from April to June, and immature fish from September to November. The annual catch has decreased since 1986, when the highest catch of 6,255 tons was recorded. In 1998, the catch reached a historical minimum of 196 tons. To increase the commercial catch of this species, the National Center for Stock Enhancement has initiated a stocking program, and since 1998, fishers have been prohibited from targeting young JSM in autumn. In 2002, the Fisheries Agency of Japan commenced implementing the nationwide stock recovery plan for depleted populations including JSM in the SIS.

To predict the effects of various scenarios of hatchery releases and fishing regulations on target populations, we developed a simple population dynamics model that accounts for variation in natural recruitment. We applied this model to the stock recovery plan for JSM in the eastern SIS and predicted probabilities to achieve the goal of the stock recovery plan, i.e., to recover the 2000 stock biomass by 1.2 times in 2006. Under the present management strategy of 10% effort reduction for immature fish with 100,000 juveniles released, the success probability for achieving the goal was evaluated at 97.2% and the expected catch was 708 tons. On the other hand, the actual catch in 2006 was 580 tons and decreased thereafter (Fig. 1).

In this model, we assumed that released fish augment the fishery production without replacement of wild by hatchery fish. Similar growth rates were also assumed for hatchery and wild fish. The gap between actual and predicted catches is discussed in terms of replacement of wild by hatchery fish and the carrying capacity, with the results given in the companion paper by Nakajima *et al.*, which will be presented in the poster session.

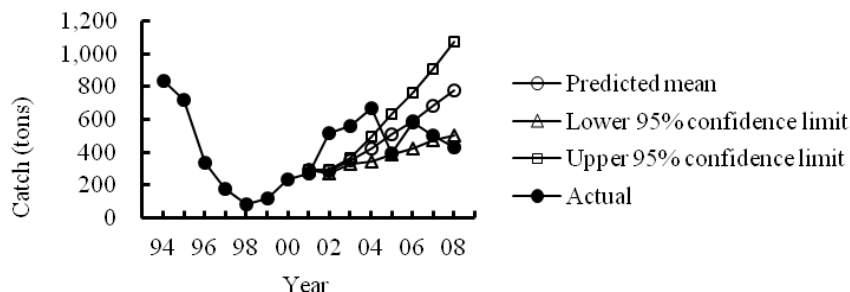


Fig. 1. Actual and predicted catch of JSM in the eastern SIS under the present management strategy of 10% effort reduction with 100,000 juveniles released.

## 25. ALLOMETRY VARIATION IN STURGEON FISHES IN SOUTHEASTERN CASPIAN SEA, ITS BIOLOGICAL IMPLICATIONS

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Variation of the allometry coefficient of WLRs can aid in the identification of factors contributing to growth model of the fishes. To investigate this coefficient in Sturgeon fishes, a total of 9055 specimens including four species of Persian sturgeon *Acipenser persicus*, Russian sturgeon *Acipenser guldenstaedti*, Stellate sturgeon *Acipenser stellatus*, Ship sturgeon *Acipenser nudiiventris* and Great sturgeon *Huso huso* were sampled in commercial sturgeon fishery (southeast Caspian Sea-Iran) between 2001 and 2006. Values of  $b$  ranged between 2.055 for males of great sturgeon to 3.551 for sexes combined group of ship sturgeon, showing considerable variation between species and among years. These findings are useful for conversion of growth-in-length equations to growth-in-weight for use in stock assessment models, to estimate stock biomass from limited sample sizes, especially based on sub-aquatic census (visual fish counting), for the calculation of production and biomass of a fish population, to estimate of population size of a fish stock for the purpose of its rational exploitation and comparison of life history and morphological features between different fish species, or between fish populations from different habitats and/or regions.

**Keywords:** allometry coefficient, sturgeon, Caspian Sea

## 26. GENETIC DISCRIMINATION OF TWO WHITE HALFBEAK SPECIES HYPORHAMPHUS UNIFASCIATUS AND HYPORHAMPHUS ROBERTI BY RFLP-PCR

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In Brazil, four out of seven species of Hemiramphidae family belong to halfbeak species, being black (*Hemiramphus brasiliensis* and *Hemiramphus balao*) and white types (*Hyporhamphus unifasciatus* and *Hyporhamphus roberti*). The white halfbeak species are overexploited due to their high value in local markets, which have threatened the sustainability of their stocks. These two species are morphologically and taxonomically distinguished by the number of gill rakers on the first lower gill arch and jaw length. Closely related species, such as these two, are quite difficult to differentiate, especially at larval stages. In restocking programs it is essential to identify nursery grounds in order to release hatchery-reared fingerlings into the wild. Among fish, most of the features used in taxonomical identification are descriptive, morphometric and meristic. This type of identification is not only time-consuming but also depends on some sort of subjectivity. Molecular biology techniques have brought new insights using DNA information. Here, we describe the genetic distinction between two halbeak species using PCR-RFLP in two mitochondrial genes, 4 NADH dehydrogenase (ND4) and 12S/16S rRNA.

A total of 40 individuals (20 of *H. unifasciatus* and 20 *H. robertii*) were sampled off Itamaracá island at the state of Pernambuco. Muscle tissue was removed and remaining material was preserved in formalin for taxonomic identification. Genomic DNA was extracted using phenol-chloroform protocol and the two mitochondrial genes were amplified by PCR. Amplicons were digested with *Bst*NI and *Rsa*I for ND4 and 12S/16S rRNA, respectively.

The amplification of ND4 gene generated a fragment of 1700 bp and the RFLP-PCR produced two bands for *H. unifasciatus*, one at 1100 and another at 600 bp, approximately. Yet for *H. robertii*, digestion showed three bands at 1000, 400 and 300 bp (Figure 1). *Hemiramphus brasiliensis* was used as an out-group and showed an RFLP-PCR banding pattern with fragments at 1200 and 500 bp. The 12S/16S rRNA amplification produced a fragment of 1500 bp. Likewise, the *Rsa*I digestion for this gene showed a banding pattern of 600, 400, 300 and 200 bp for *H. unifasciatus* and 800, 300 and two of 200bp for *H. robertii* (Figure 2).

It is possible to conclude that RFLP-PCR of these two mitochondrial genes was capable of discriminating between the two white halfbeak species that occur off Brazilian coast. This approach will contribute in the location of nursery grounds, which is important to the success of restocking programs.

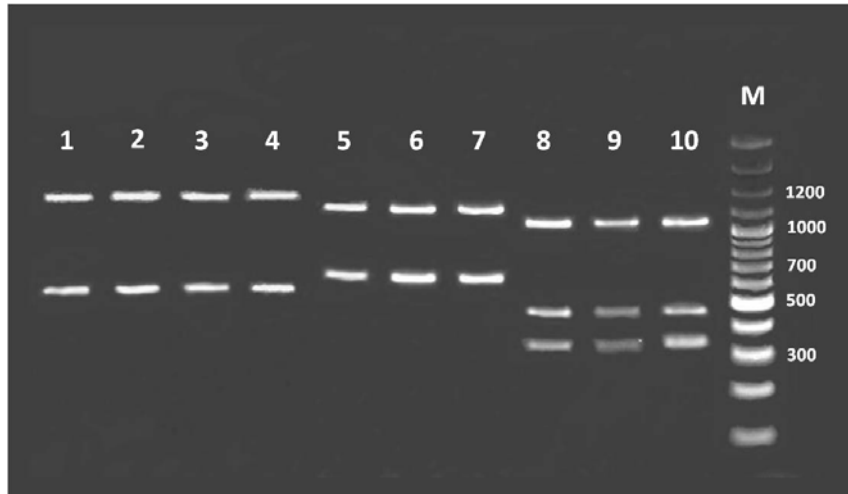


Figure 1 – Digestion with restriction enzyme *BstNI* of ND4 gene. Lanes 1, 2, 3 and 4: *Hemiramphus brasiliensis* (out-group) – 1200 and 500 bp; Lanes 5, 6 and 7: *Hyporhamphus unifasciatus* – 1100 and 600 bp; Lanes 8, 9 and 10: *Hyporhamphus roberti* – 1000, 400 and 300 bp. Lane 7: DNA ladder.

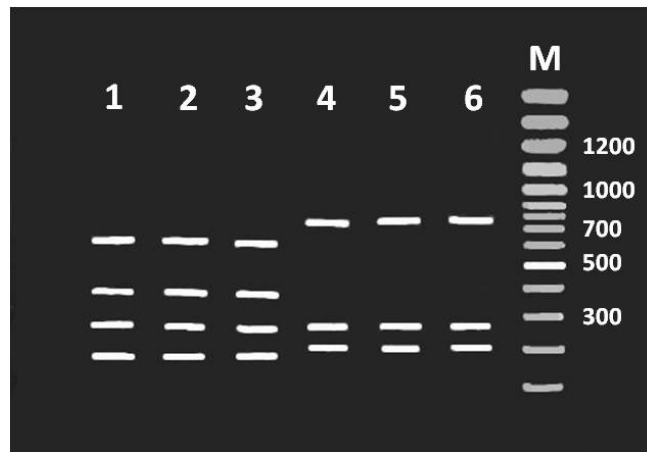


Figure 2 – Digestion with restriction enzyme *RsaI* of 12S/16S gene. Lanes 1, 2 and 3: *Hyporhamphus unifasciatus* – 600, 400, 300 and 200 bp; Lanes 4, 5 and 6: *Hyporhamphus roberti* – 800, 300 and two of 200 bp. Lane 7: DNA ladder.

## 27. A GENERALISED NUMERICAL APPROACH FOR CONTROLLING ECOLOGICAL RISKS OF HATCHERY-RELEASES AND ASSESSING STOCKING SCENARIOS IN OPEN SYSTEMS

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Rigorous assessment of species and ecosystem biology underpins responsible marine stock enhancement. Estimation of appropriate stocking density based on ecosystem productivity and energetic requirements of stocked species can refine the magnitude of release densities used in pilot-scale enhancement experiments, minimizing waste of resources and the possibility for adverse stocking effects. A generalised mass-balance model for stocking density estimation is proposed. The approach is loosely based on the principles of ECOPATH, and modified for the dynamic estimation of stocking-related ecosystem relationships at fine temporal (days) and spatial scales. Main parameter inputs include probability distributions for key biological and life history aspects for stocked species, and estimates of primary productivity for the target ecosystem. The energetic requirements of stocked fish are evaluated in terms of growth and mortality, and ontogenetic transitions in diet, habitat use, morphology and migration. The theoretical carrying capacity for a stocked species within a given arena is assessed from primary productivity, levels of predation on different prey groups. The model performs a monte-carlo analysis of uncertainty to estimate the relative probability of different stocking densities given a specified productivity threshold. Stocking density is evaluated through dynamic evaluation of energetic requirements against productive capacity of the spatial habitat range for stocked fish. The model is applied for stocking early stages for a range of species and geographic areas, including snook (*Centropomus undecimalis*) and red drum (*Scianops ocellata*) in the Gulf of Mexico USA, and mulloway (*Argyrosomus japonicus*) and flathead (*Platycephalus fuscus*) in Australia.

## 28. POPULATION DYNAMICS OF FISHES IN LITTORAL MARINE WATERS OF THE MEKONG DELTA, SOUTH OF VIET NAM

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The population dynamics of seven commercial species of fish (*Congresox talabon*, *Cynoglossus cynoglossus*, *Peneahia argentatus*, *Peneahia pawak*, *Trichurius lepturus*, *Trypaugen vagina*, and *Upeneus sulphureus*) distributed in littoral marine zone of the Mekong Delta were investigated. Length-based stock assessment using FiSAT II software package was used to assess the growth and mortality parameters such as asymptotic size ( $L_{\infty}$ ), growth coefficient (K), total (Z) and natural (M) mortality, exploitation rate (E), recruitment pattern, current probability of capture and selectivity of fishing gears. Yield-per-recruit analyses were carried out showing different levels of the exploitation. Results showed that the maximum sustainable yield would be reached for an exploitation rate higher than the current one for each population. However, the size at first capture should be increased for every population. The findings indicated that the current exploitations of fish

populations distributed in littoral marine zone of the Mekong Delta are under exploitation level for maximum sustainable yield; however, all the fish populations are subject to growth over-exploitation.

**Key words:** Marine fish; Mekong Delta; Population Parameters; Length-based

## **29. CHALLENGES IN MANAGING THE WETLANDS OF THE YELLOW RIVER DELTA IN THE FACE OF ECONOMIC DEVELOPMENT AND CLIMATE CHANGE**

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Covering an area of 6000 km<sup>2</sup> and still accreting, the Yellow River Delta (YRD) is the most rapidly-expanding delta system, with the youngest wetland ecosystem being created in the world. It supports a rapidly-modernizing Dongying municipality in Shandong province, fueled by petroleum revenue from China's second richest oil field located within the delta. But the YRD, which is already highly vulnerable to natural coastal phenomena (monsoon, El-Nino, flooding and storm surges) and upstream anthropogenic activities (causing reduced flow and changes in sediment and nutrient transport), is additionally susceptible to the impacts of climate change, sea level rise and associated increase in frequency and severity of coastal extreme events. Response measures undertaken include construction of coastal dykes to protect lives, property and the diverse economic activities ranging from agriculture and aquaculture to modern industrial development. Dongying attempts to balance modern development with conservation of 37,000 ha of the youngest and pristine wetlands at the estuary of the Yellow River, and requires more compelling justification for the latter. The paper reports on a study to highlight the indirect value of the natural wetlands in the YRD in providing ecosystem services, including climate change mitigation, that would support such justification, and trade-offs in the present uses of the wetland resources. The study conducted multi-criteria evaluation within a GIS platform to assess four wetlands ecosystem services considered important in the Dongying context - providing direct economic uses, supporting biodiversity, water quality regulation through nutrient retention, and mitigating climate change impacts through carbon sequestration. Local experts rated, by assigning scores, the extent to which each of these ecosystem services are changed by the different uses of the wetlands in the study area, and the scores were mapped for each ecosystem service. Two main recommendations were made based on the findings. The first concerns conducting scientific studies on the pristine wetlands in the conservation area for quantifying the non-use value of the YRD wetlands. In particular, valuing the role of wetlands as carbon sinks will support the eligibility claim for inclusion of temperate coastal wetlands for carbon credits, thereby financially rewarding the conservation of these wetlands. The second recommendation relates to practicing low-impact and biodiversity-enhancing agriculture and low-carbon aquaculture that can provide good economic returns with reduced carbon footprints. The argument is made that carefully-chosen and well-managed economic activities can coexist with natural wetland conservation and complement the ecosystem services that the YRD wetlands provide.

### 30. TRANSCRIPTOMIC PROFILES OF JAPANESE MEDAKA (*ORYZIAS LATIPES*) IN RESPONSE TO ALKALINITY STRESS

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Alkalinity stress is considered to be one of the major stressors for fish in saline-alkali water. Thus, it is of great significance from both aquaculture and physiological viewpoint to understand the molecular genetic response of aquatic organisms to alkalinity stress. The objective of this study is to determine genome-wide gene expression profiles to better understand the physiology response of medaka (*Oryzias latipes*) to high carbonate alkalinity stress. In lab-based cultures, adult fish were exposed to freshwater and high carbonate alkalinity water. We design a microarray containing 26429 genes and describe our experimental results for measuring gene expression changes in the gill of carbonate alkalinity stress exposed fish. Using T-test methods, we determined that 512 genes were up regulated and 501 genes were down regulated in the gill of medaka exposed to carbonate alkalinity stress. These differentially expressed genes can be divided into a number of biological gene ontology groups related to multicellular organismal process, response to stimulus, developmental process, metabolic process, catalytic activity, electron carrier activity, immune system process, extracellular region and transcription regulator activity. Biological pathways, mTOR signalling pathway, nitrogen metabolism, MAPK signalling pathway, calcium signalling pathway, GnRH signalling pathway etc. were significantly regulated. Alkalinity stress stimulates the energy and ion regulated pathway, at the same time slows down the pathways related to immune system and reproduction of medaka.

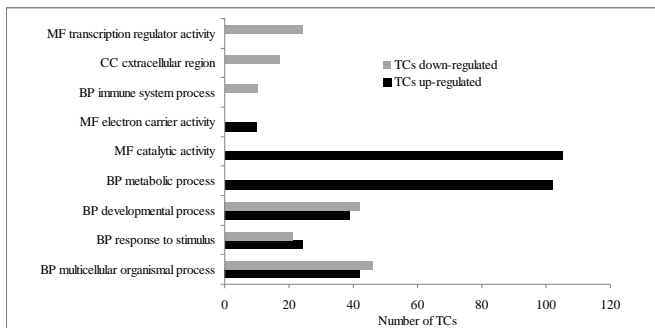


Figure 1. Number of gene ontology groups of medaka differentially expressed genes exposed to alkalinity stress (MF is the abbreviation for molecular function, BP for biological process and CC for cellular component)

### **31. Management of stress in stock enhancement and sea ranching**

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Stress is a part of life, and all life have evolved strategies to cope with stressor in their lives. What is stress? We propose that the term 'stress' should be the non-specific physiological cascade of events that occurs when the organism is attempting re-establish homeostatic norms in facing demand from environment and themselves. The stress response is subserved by the stress system, which is located both in the central nervous system and the periphery. Appropriate responsiveness of the stress system to stressors is a crucial prerequisite for a sense of well-being, adequate performance, and positive social interactions. During the releasing process, marine animal often subject to a number of stressor include physical and mental trauma associated with capture, transport, handling, and crowding; variations in water temperature, oxygen, salinity, chemical contaminants and pathogen exposure in new environment. This paper will review study on stress, and emphasize the importance for releasing strategy of restocking, stock enhancement and sea ranching.

Key words: Stress, stock enhancement, sea ranching