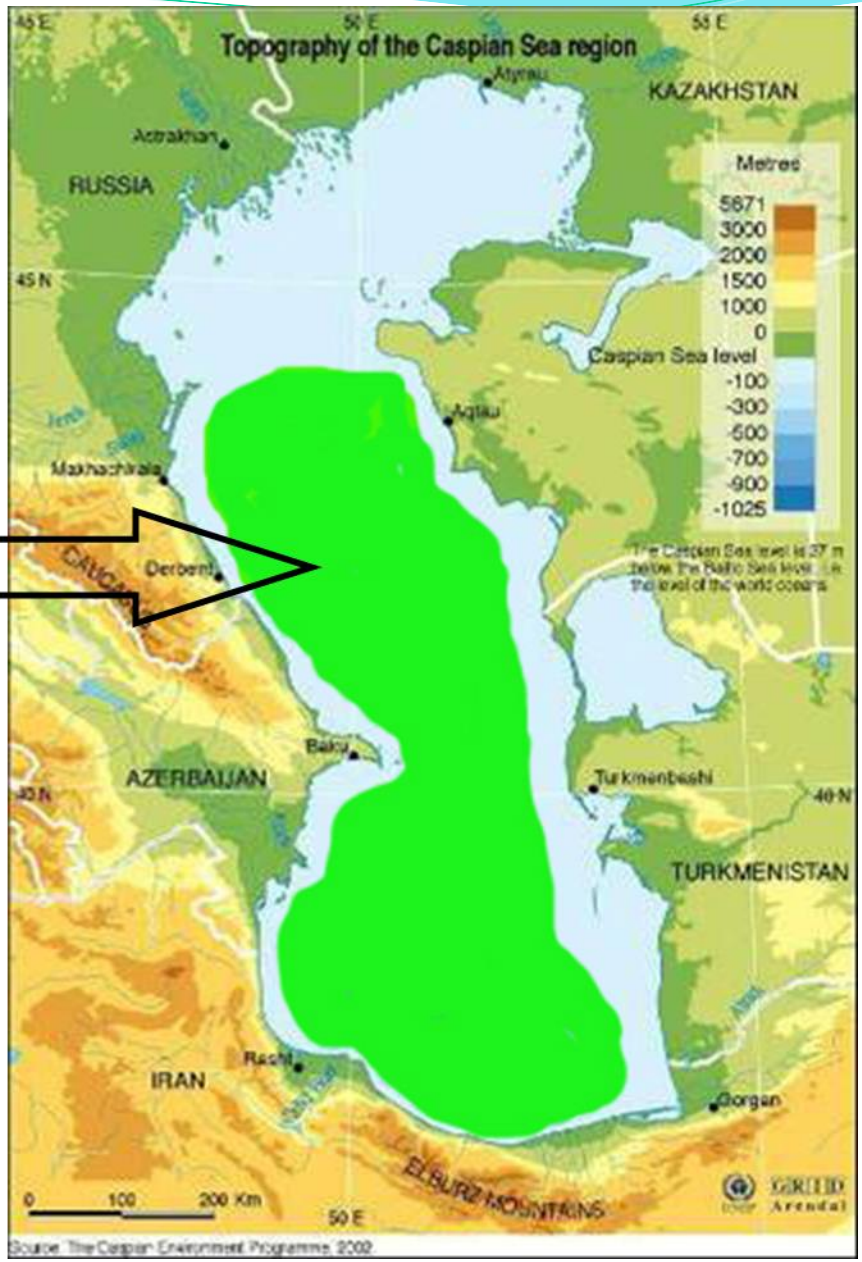
Iranian Fisheries Science Research Institute
Caspian Sea Ecology Center

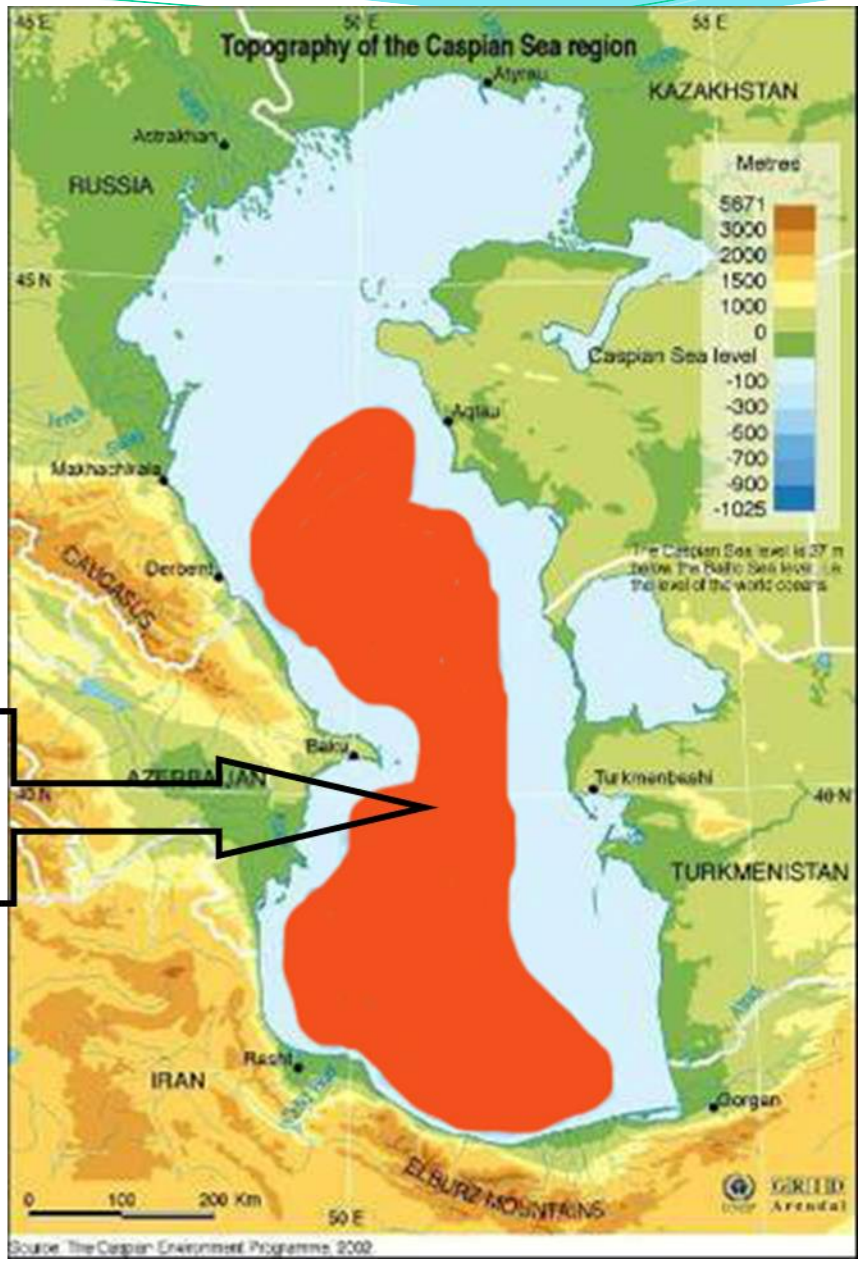
The Results of the Recent Monitoring of Kilka resources in South Caspian Sea

- Introduction

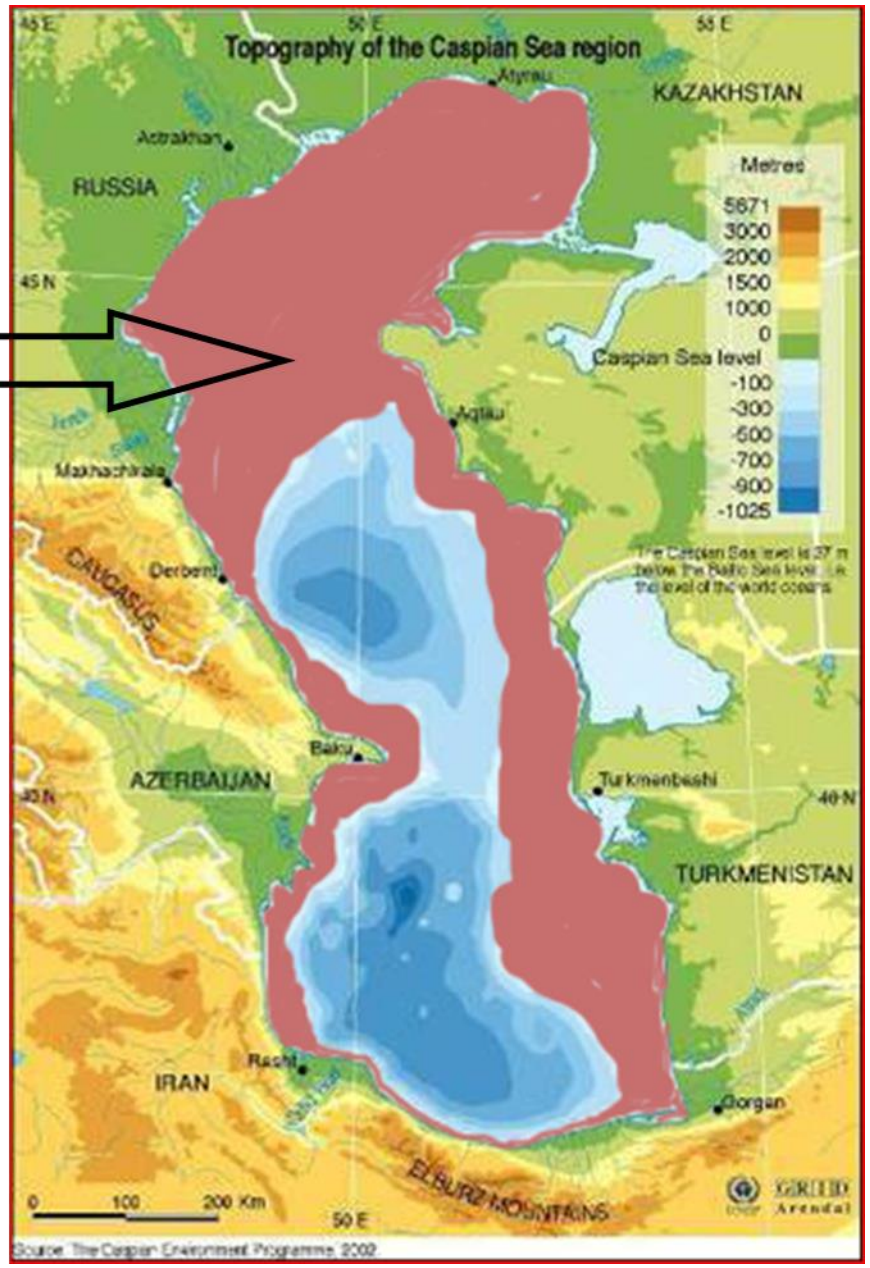
Anchovy kilka *Cl. engrauliformis*



Bigeye kilka *Cl. grimmi*



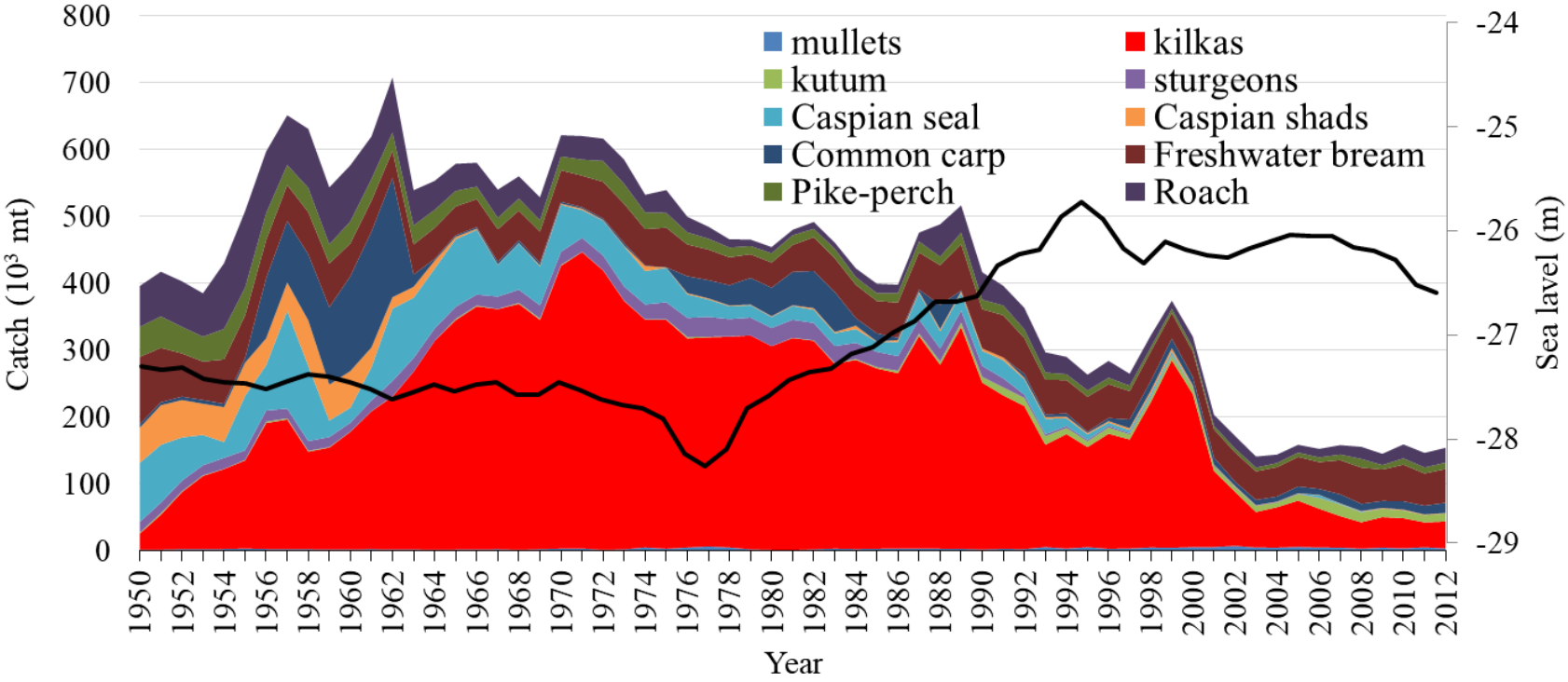
Common kilka *Clupeonella cultriventris caspia*



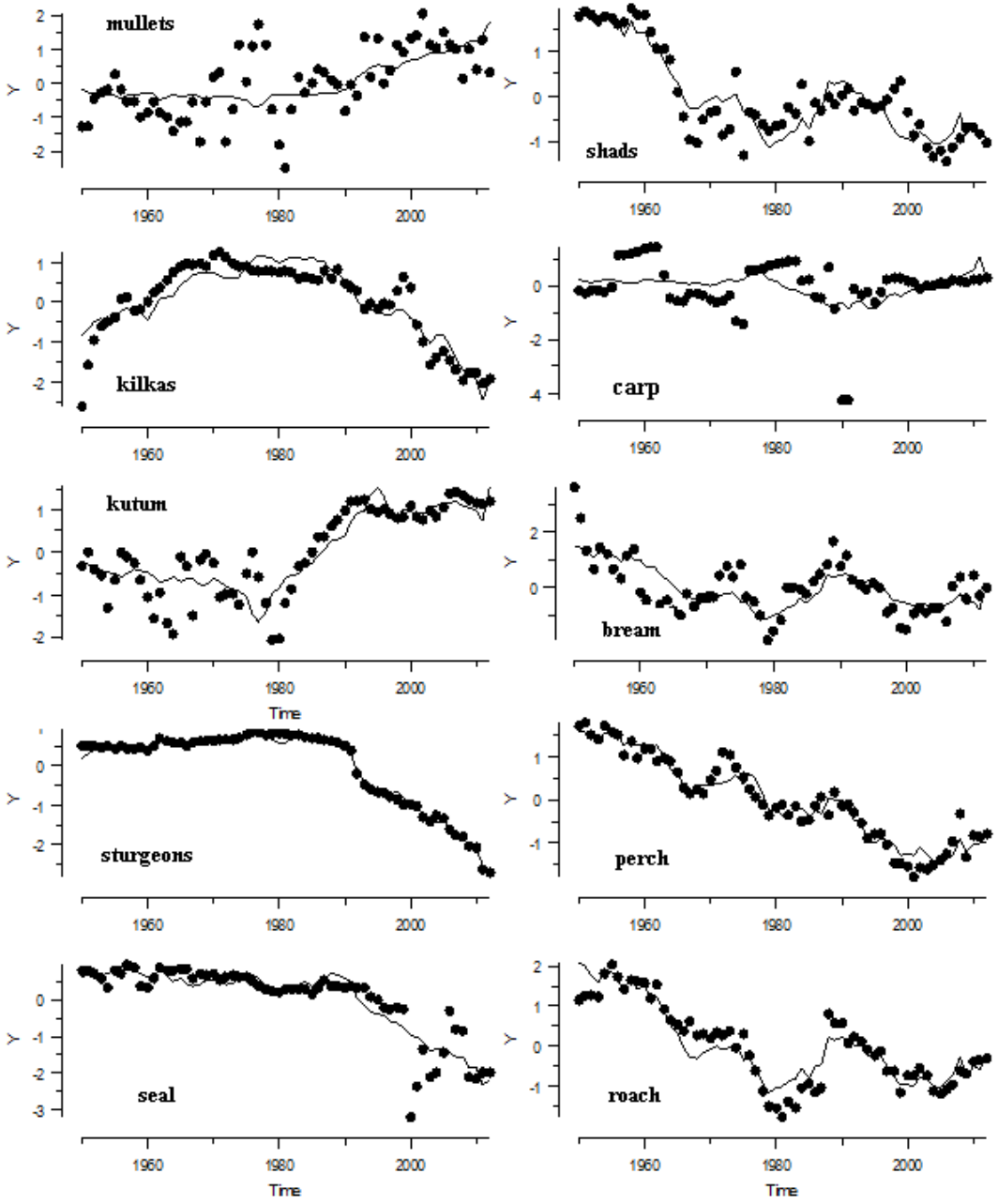
- Importance of kilkas:

1. Kilka fisheries is important sources of income and protein in the Caspian Sea. It contributed 70% of the fish catch (200-400 thousands mt)

2. The main food item for predators (top trophic level) specially Sturgeon and Caspian Seal (500 thousands mt)



Annual catches of Caspian main species/groups (data source on catches: Fishstat Plus, FAO Fisheries Department, FISHSTAT Plus), black thick line is Caspin Sea Level.



Observed (filled circles) and fitted (lines) landings of the dynamic factor analysis model with two common trends and two explanatory variables

Fazli, H., Ghanghermeh, A.A., Shahifar, R. 2017. Analysis of landings and environmental variables time series from the Caspian Sea. Environmental Resources Research. 5, 1-12.

In the present study,

1. population parameters,
2. biomass and
3. optimal levels of catch and fishing effort of three species of kilkas was estimated in Iranian waters of the Caspian, from 1995-96 to 2017-18.
4. The effects of new invasion species (*Mnemiolysis leidyi*) on the component of the Caspian Sea

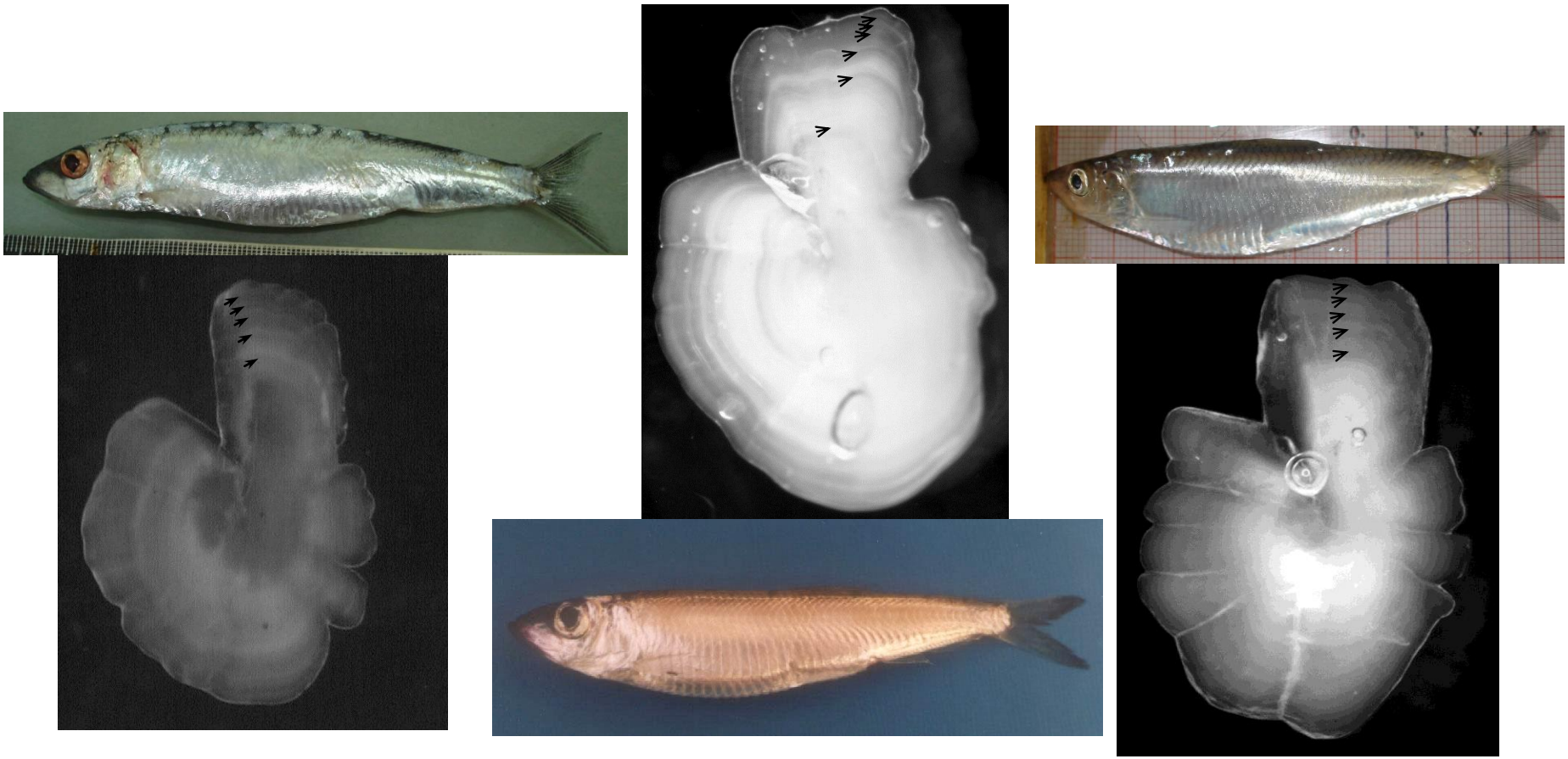
Material and Methods

Sampling area

Field sampling of commercial catches was conducted by staff of the Ecology Institute of the Caspian Sea and Bony Fishes Research Center/IFRO in the Iranian provinces of Mazandaran and Guilan during 1995-2018.

The kilkas examined in this study were caught by commercial vessels at depths ranging from 40 to 100 m by conical liftnets equipped with underwater electric lights.
The fishing vessels are small (15-100 tons capacity) and fishing operations are conducted at night.

➢ Age determination



Whole embedded otolith of **(a) anchovy kilka** (112 mm fork length), (b) **bieye kilka** (130 mm fork length) and (c) **common kilka** (98 mm fork length). Arrows indicate opaque zones.

Length-weight relationship

$$W = aL^b$$

Condition Factor (CF)

$$CF = \frac{W}{L^b} \times 100$$

von Bertalanffy Growth Curve

$$L_t = L_\infty (1 - e^{-K(t-t_0)})$$

Instantaneous Natural Mortality

(Zhang and Megrey, 2006)

$$\hat{M} = \frac{\beta K}{e^{K(t_{mb}-t_0)} - 1}$$

Survival rate (*S*) was calculated using the catch curve method to estimate Terminal F. The instantaneous coefficient of total mortality (*Z*) was transformed from the survival rate as $Z = -\ln S$.

Where L_t is the length at age t, L_∞ is the theoretical maximum length, k is a growth coefficient, t_0 is the hypothetical age for $L_t=0$, M is the instantaneous coefficient of natural mortality, the power parameter of the length-weight relationship, and t_{mb} is the critical age.

Biomass and instantaneous coefficient of fishing mortality (F):

Biomass-based cohort analysis (Zhang and Sullivan, 1988) was used to estimate biomass and *F*

Biomass

$$B_{ij} = B_{i+1,\,j+1}e^{(M-G_j)} + C_{ij}e^{(M-G_j)/2}$$

Instantaneous coefficient of growth rate (G)

$$G_j = \ln(\frac{W_{j+1}}{W_j})$$

Instantaneous fishing mortality

$$F_{ij} = \ln(\frac{B_{ij}}{B_{i+1,\,j+1}}) - M + G_j$$

Exploitation

$$E = \frac{F}{Z}(1-e^{-Z})$$

Optimal fishing mortality and optimal age at first capture:

Yield-per-recruit and Spawning biomass per recruit was estimated by Beverton & Holt (1957) model.

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where C_{ij} is the catch in weight at age *j* in year *i*, B_{ij} and $Bi+1,j+1$ are the biomass at age *j* and *j*+1 in year *i* and *i*+1, F_{ij} is the instantaneous coefficient of fishing mortality at age *j* in year *i* and G_j is the instantaneous coefficient of growth at age *j* , W_j and W_{j+1} are the body weight at age *j* and *j+1*

Methods used to determine the acceptable biological catch (ABC) in the Iranian fisheries management system (from Zhang and Lee, 2001).

Tier 1. Information available: Reliable estimates of B, B_{MSY}, F_{MSY} and $F_{40\%}$

1a) Stock status: $B/B_{MSY}>1$

$F_{ABC}=F_{MSY}$

1b) Stock status: $\alpha<B/B_{MSY}\leq 1$

$F_{ABC}=F_{MSY}\times(B/B_{MSY}-\alpha)/(1-\alpha)$

1c) Stock status: $B/B_{MSY}\leq \alpha$: $F_{ABC}=0$

Tier 2. Information available: Reliable estimates of B, $B_{X\%}$ and $F_{X\%}$

2a) Stock status: $B/B_{40\%}>1$

$F_{ABC}=F_{40\%}$

2b) Stock status: $\alpha<B/B_{40\%}\leq 1$

$F_{ABC}=F_{40\%}\times(B/B_{40\%}-\alpha)/(1-\alpha)$

2c) Stock status: $B/B_{40\%}\leq \alpha$: $F_{ABC}=0$

Tier 3. Information available: Reliable estimates of B and $F_{0.1}$

$F_{ABC}=F_{0.1}$

Tier 4. Information available: Times series catch and effort data

4a) Stock status: $CPUE/CPUE_{MSY}>1$

ABC=MSY

4b) Stock status: $\alpha<CPUE/CPUE_{MSY}\leq 1$

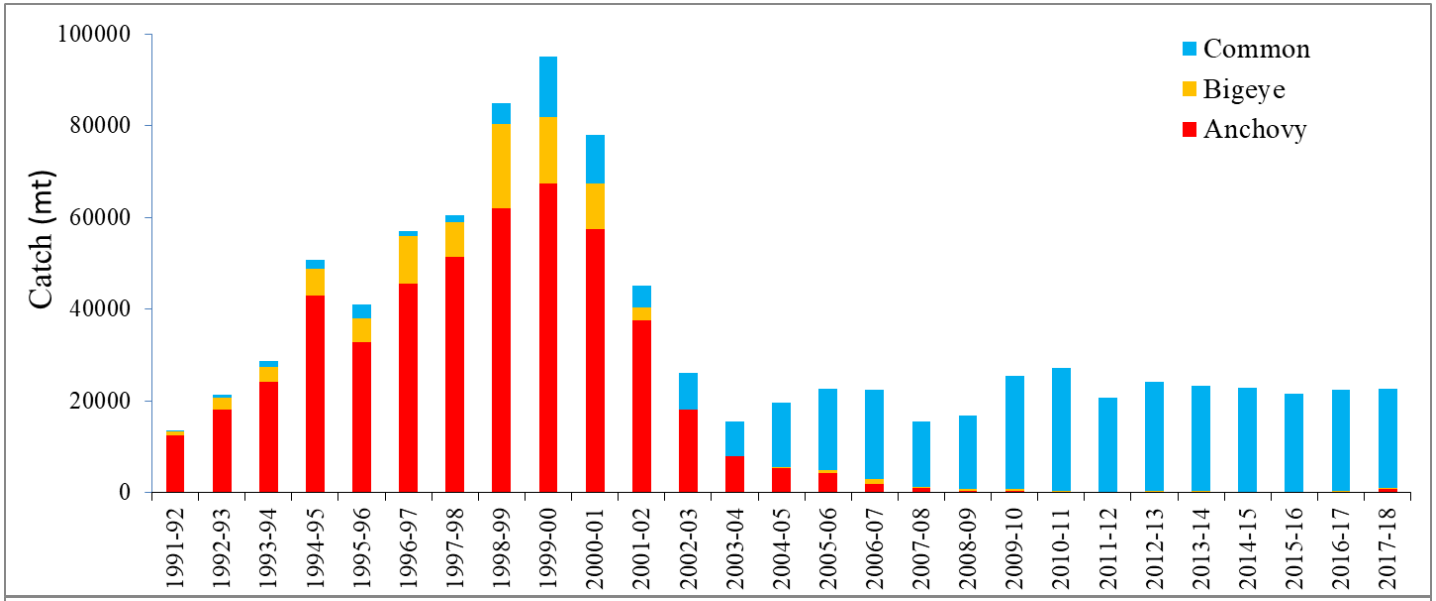
$ABC=MSY\times(CPUE/CPUE_{MSY}-\alpha)/(1-\alpha)$

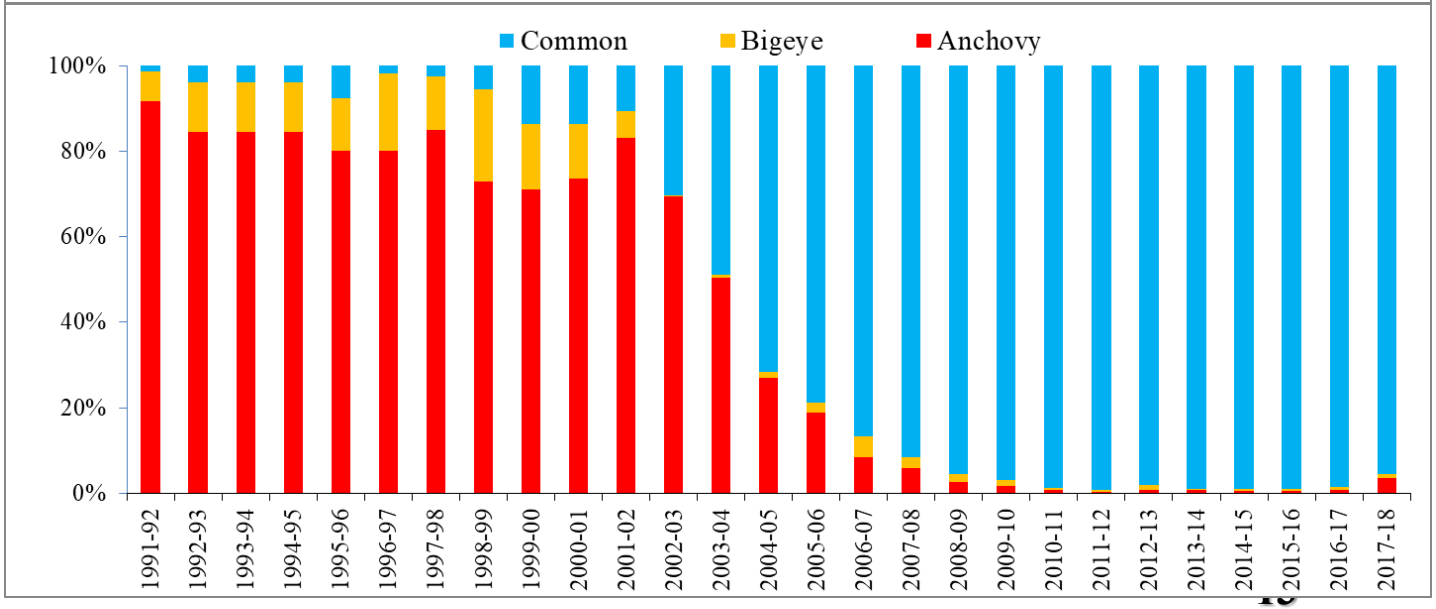
4c) Stock status: $CPUE/CPUE_{MSY}\leq \alpha$: ABC=0

Tier 5. Information available: Reliable catch history

ABC=$P\times Y_{AM}$ (arithmetic mean catch over an appropriate time period), $0.5\leq P\leq 1.0$

- Results and Discussion
  - Catch and species composition





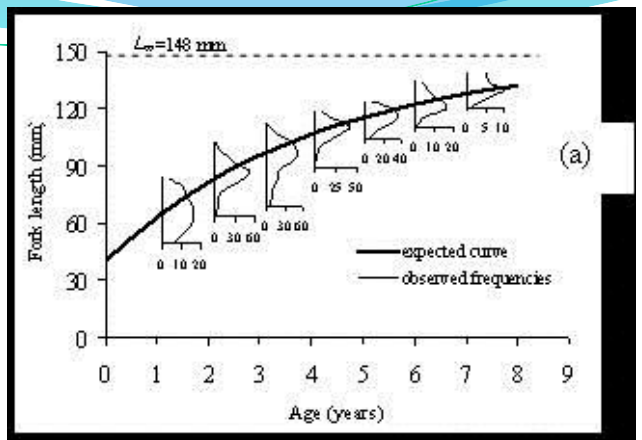
Catch of three species of kilkas in Iranian waters of the Caspian Sea

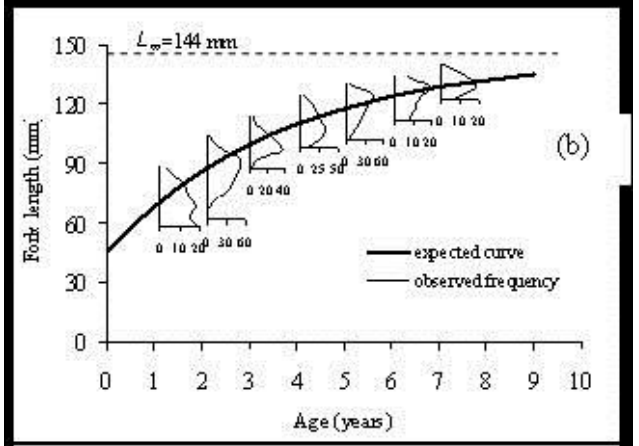
- Growth parameters

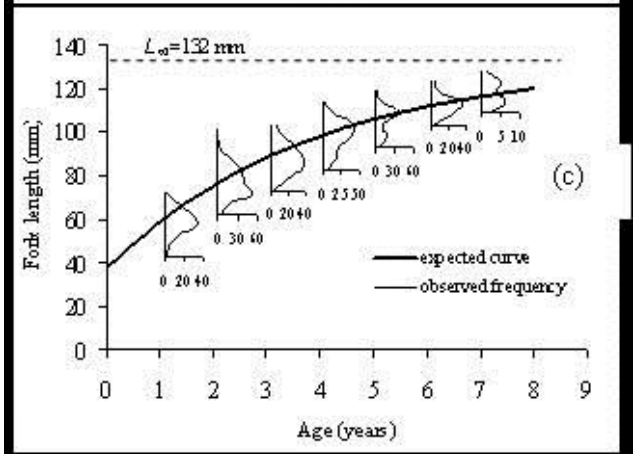
$$L_t = 148(1 - e^{-0.238(t+1.340)})$$

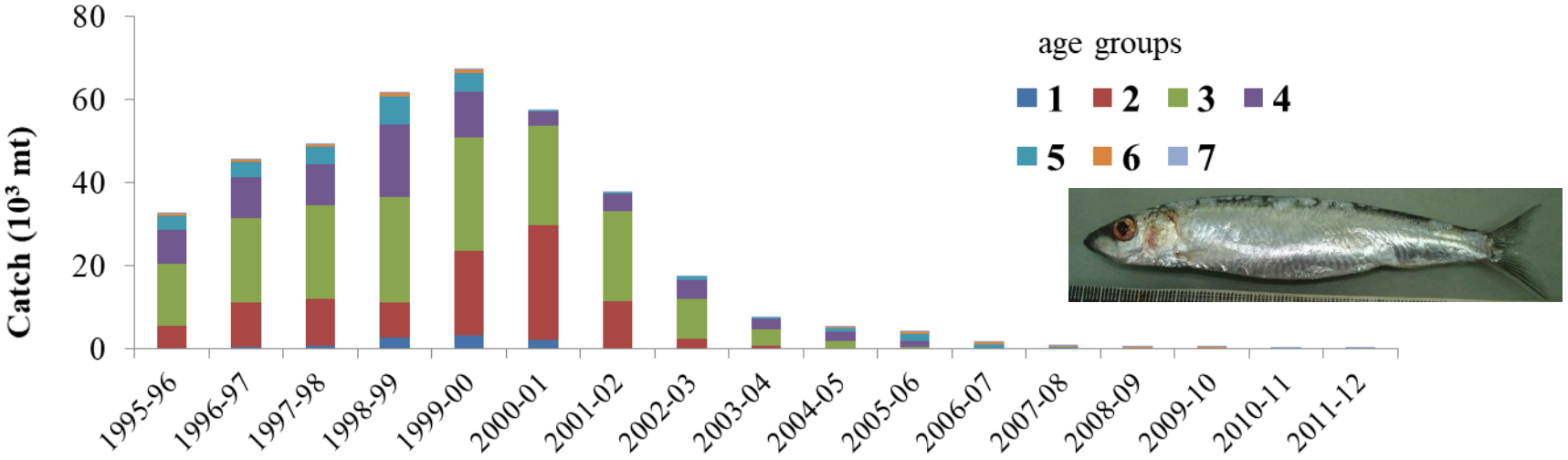
$$L_t = 144(1 - e^{-0.265(t+1.422)})$$

$$L_t = 132(1 - e^{-0.259(t+1.285)})$$

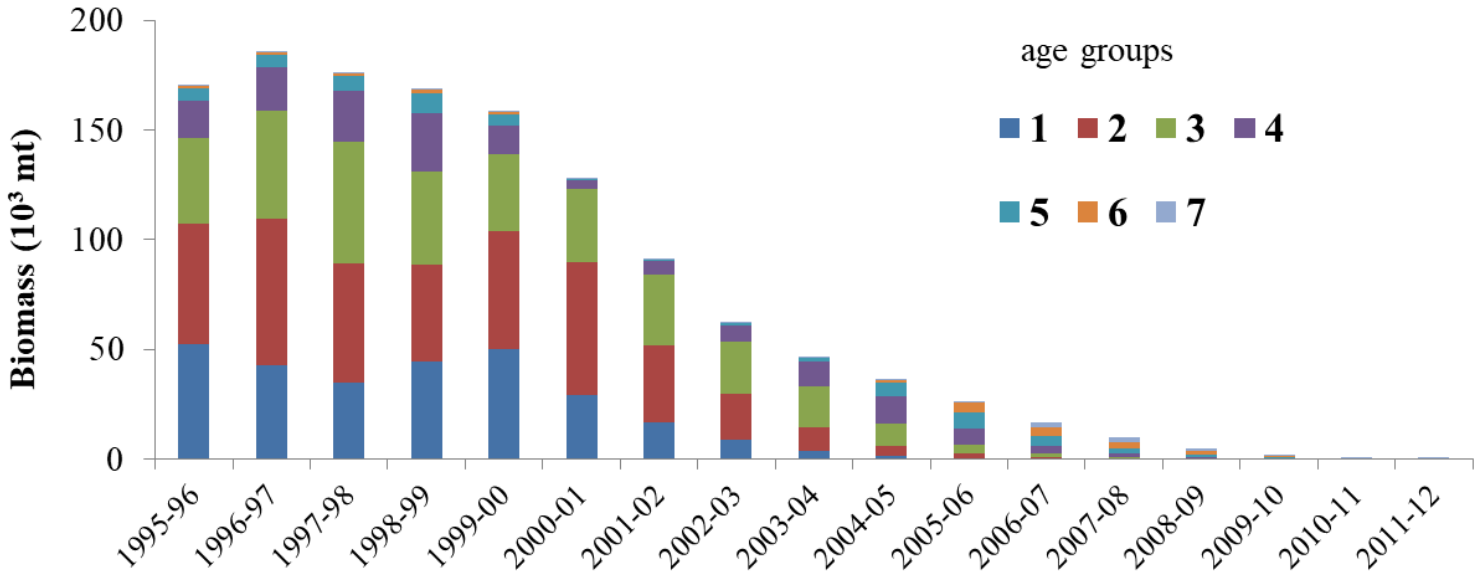




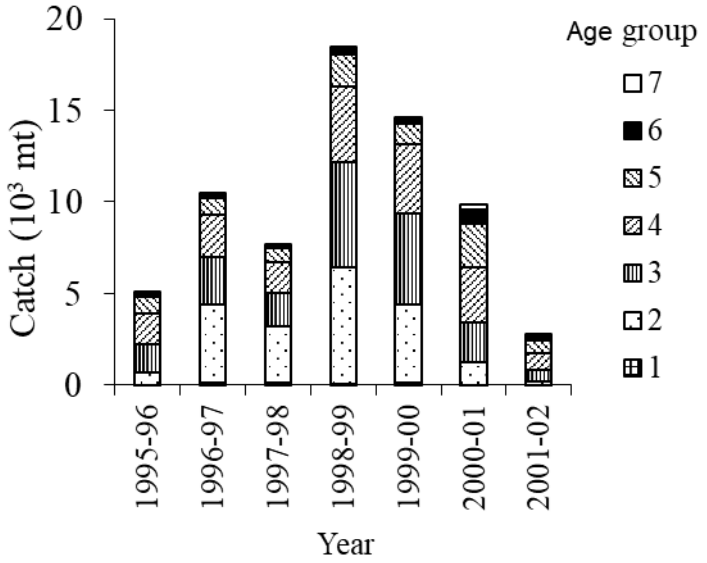


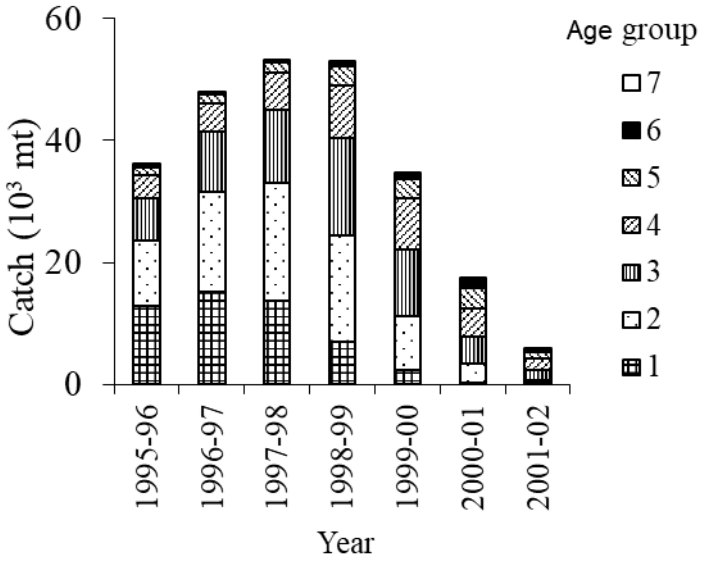


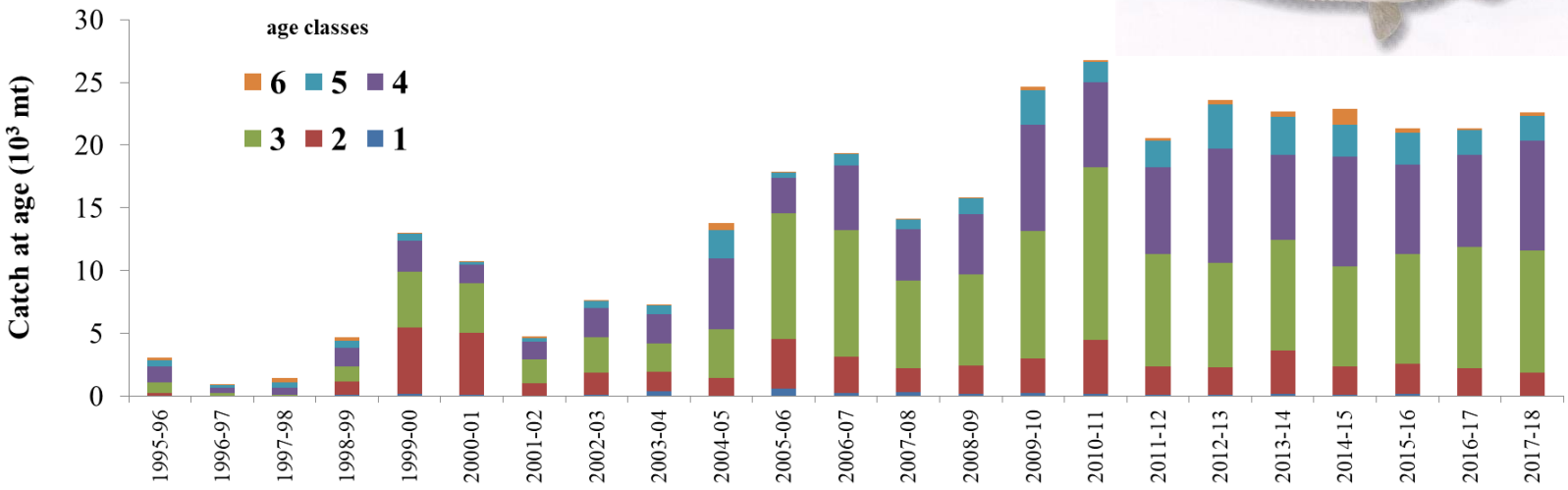
Catch (top) and Biomass (down) at age of anchovy kilka in Iranian waters of the Caspian Sea, during from 1995-96 to 2011-12



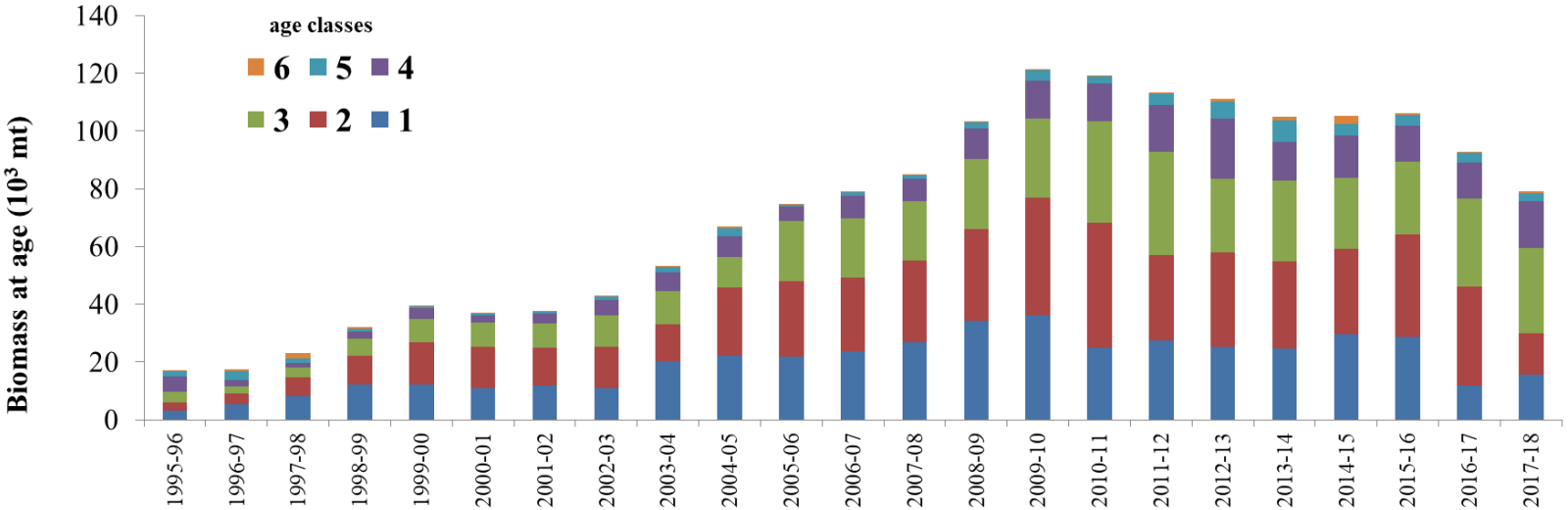
Catch (top) and Biomass (down) at age of bigeye kilka in Iranian waters of the Caspian Sea during from 1995-96 to 2001-02







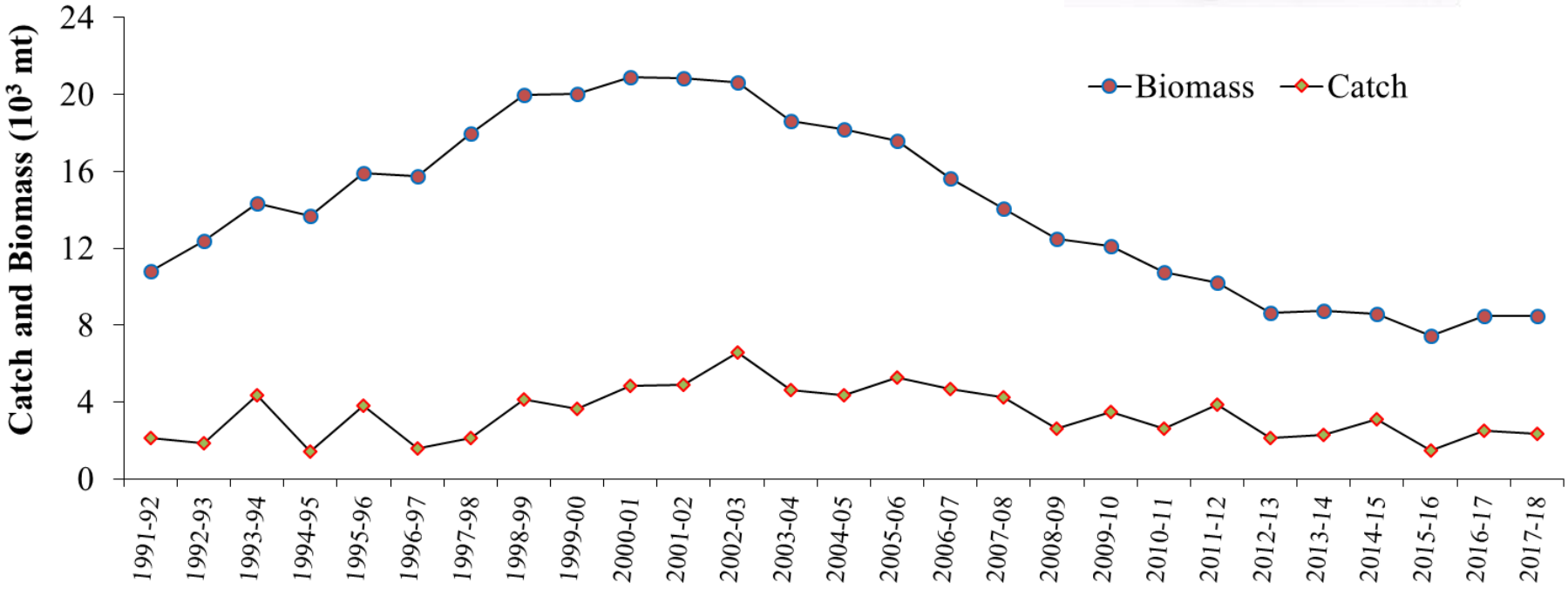
Catch (top) and Biomass (down) at age of common kilka in Iranian waters of the Caspian Sea, during from 1995-96 to 2017-18



According to the present stock status of three species of kilkas, the common kilka stock is sustainable.

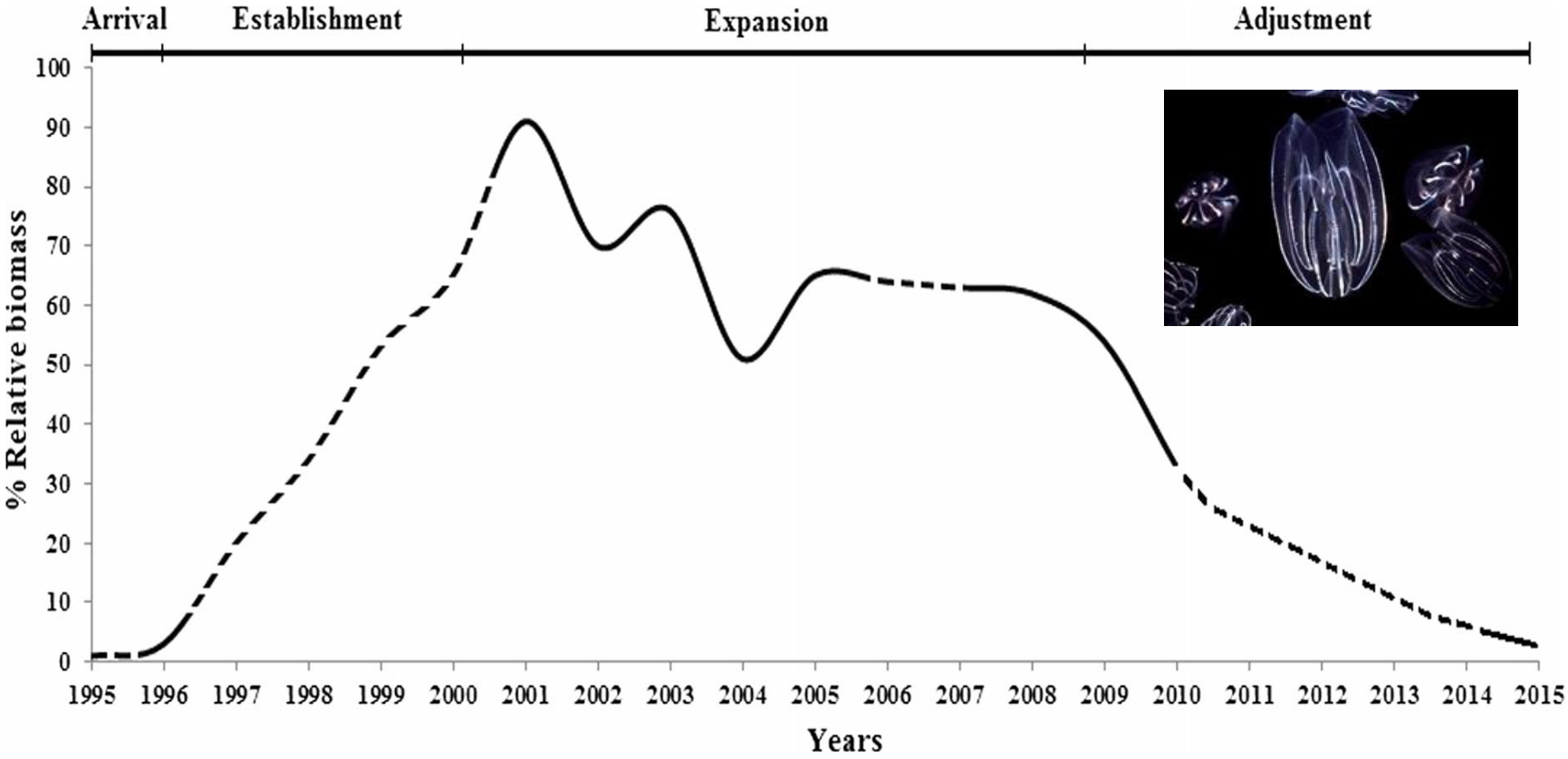
ABC (acceptable biological catch) estimates for common kila by the Iranian TAC fisheries management system.

	Stock status	ABC (mt)
Tier 1	B_{MSY}, F_{MSY} = not available	Not available
Tier 2	with current t_c = 2.4: $B/B_{35\%}$= 81,960/87,000<1	
	Stock status: 2b	
	$F_{ABC}=F_{35\%}\times(B/B_{35\%}-\alpha)/(1-\alpha)=0.71$/yr	
	with current t_c= 2.4; $F_{ABC}=F_{0.1}$=0.90/yr	18,650
Tier 3	CPUE/$CPUE_{MSY}$= Not available	21,000
Tier 4	Stock status: 4b	Not available
Tier 5	Y_{AM}	20,500

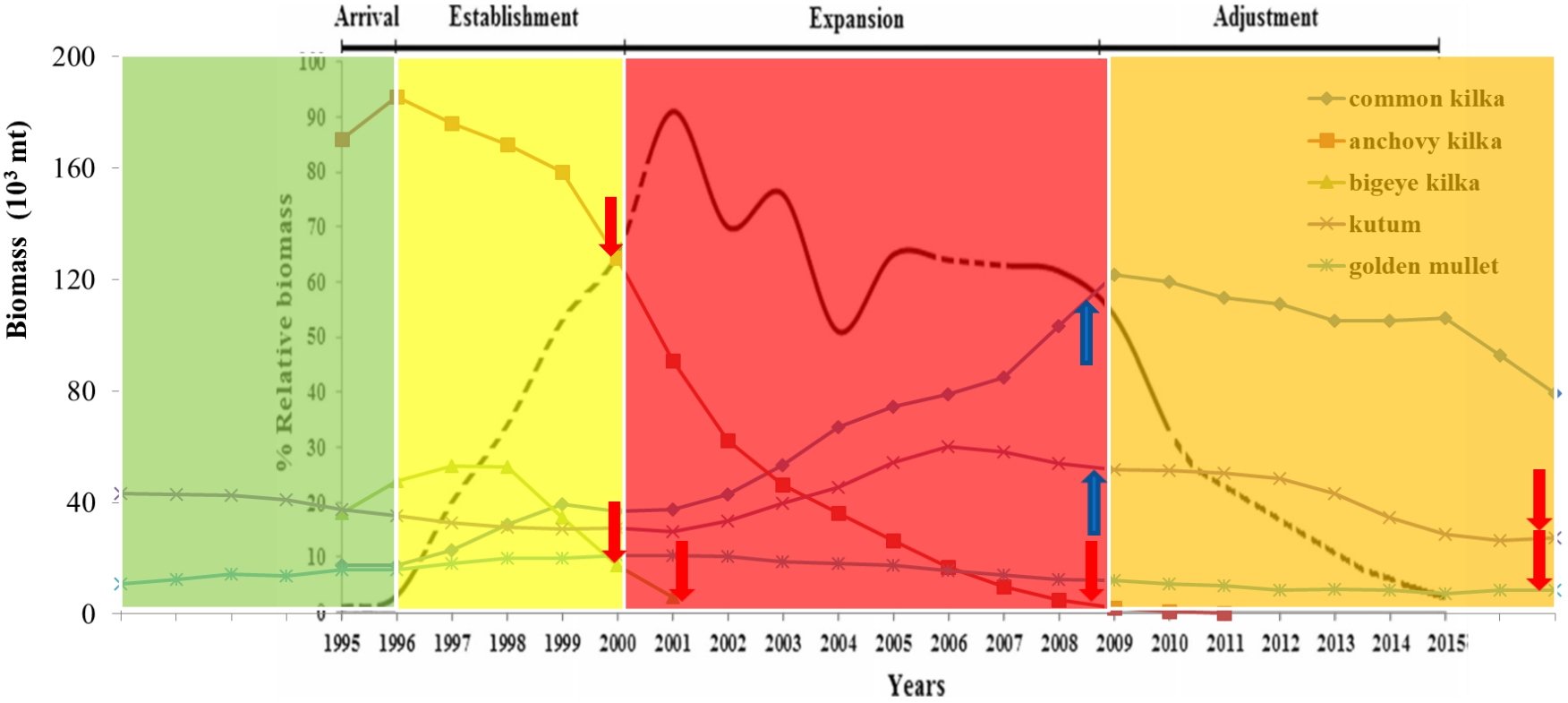


Catch (top) and Biomass (down) at age of golden gray mullet in Iranian waters of the Caspian Sea, during from 1991-92 to 2017-18

Catch (top) and Biomass (down) at age of kutum in Iranian waters of the Caspian Sea, during from 1991-92 to 2017-18



Phases of *Mnemiopsis leidyi* invasion in the southern Caspian Sea. The dashed lines indicate the years in which the relevant published results are not available (Pourang et al., 2016)



Attention: the stocks of 5 species of sturgeons declined sharply, during two last decades.

Therefore, most of commercial fish species stocks collapsed in Iranian waters of the Caspian Sea

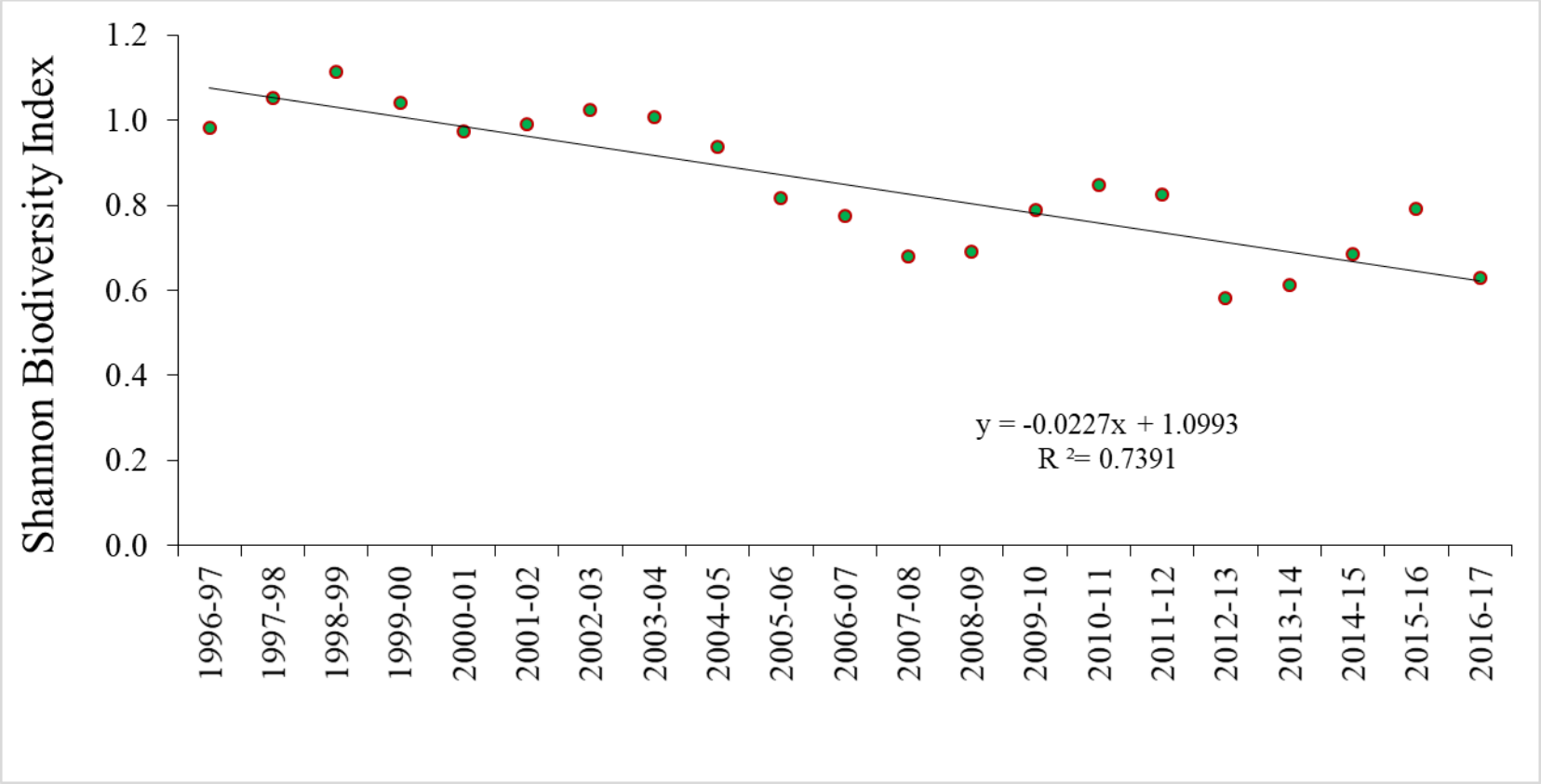
Assessment of the biopollution level (BPL) caused by *Mnemiopsis leidyi* in different marine Ecosystems (**Pourang et al., 2016**)

The abundance and distribution range (ADR, A is low and E is high numbers, respectively), impact on native communities (C, 0 native species unchanged and 4 extinction of native keystone species), on habitats (H, 0 is no effect and 4 is massive effect), and ecosystem functioning (E, biomass decreased less than 20 % in group E0; 21-40 % in E1; 41-60 %in E2; 61-80 % in E3; and over 81 % in E4)

Study area	Year	ADR	C	H	E	BPL	Reference
Southern Caspian Sea	2001	E	C4	H0	E1	4	Present study
Southern Caspian Sea	2002	E	C4	H0	E2	4	Present study
Southern Caspian Sea	2003	E	C4	H0	E2	4	Present study
Southern Caspian Sea	2004	E	C4	H1	E1	4	Present study
Southern Caspian Sea	2005	E	C4	H3	E1	4	Present study
Southern Caspian Sea	2008	E	C4	H3	E2	4	Present study
Southern Caspian Sea	2009	E	C4	H3	E1	4	Present study
Southern Caspian Sea	2010	D	C4	H2	E2	4	Present study
Black Sea	1982	A	C0	H0	E0	0	Olenin et al. (2014)
Black Sea	1987	C	C2	H2	E2	2	Olenin et al. (2014)
Black Sea	1989	E	C3	H4	E4	4	Olenin et al. (2014)
Baltic Proper	2007	D	N/A	N/A	E1	2	Zaiko et al. (2011)
Gulf of Gdansk	2007	C	N/A	N/A	N/A	1	Zaiko et al. (2011)
Kattegat and Belt Sea	2007	D	C2	N/A	N/A	2	Zaiko et al. (2011)

In the Caspian, the IAS impact on the habitats (H) and ecosystem functioning (E) during the study period, the impact on the native species and communities throughout the period as massive (C4). The BPL is determined the greatest impact level 4, during 2001-2010.

The BPLs by *M. leidyi* in the Black Sea levels vary between 0 and 4.


Shannon Biodiversity Index
1.2
1.0
0.8
0.6
0.4
0.2
0.0
y = -0.0227x + 1.0993
R ²= 0.7391
1996-97
1997-98
1998-99
1999-00
2000-01
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
2016-17

1. In order to obtain a better understanding of the current status of *M. leidyi* distribution and population dynamics in the in the whole area of the Caspian Sea, implementation studies about the ADR, the impact magnitude of the invasive comb jelly on native communities, habitats and ecosystem functioning is highly advisable.

2. The most fish species was considered to be at risk of extinction, due to habitat destruction, environmental degradation, overexploitation and …, then a coordinated regional and international effort is highly advisable to provide immediate implementation of stock enhancement and management in the Caspian Sea.

Thank you for your attention