IMPACT OF CLIMATE ANOMALY ON CATCH COMPOSITION OF NERITIC TUNA IN SUNDA STRAIT

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ABSTRACT

Tongkol komo/kawakawa (Euthynnus affinis) and tenggiri (Scomberomerus guttatus) are commonly caught by mini purseiners operated in Sunda Straits and landed in Labuan, West Java. This species inhabits coastal water and has preference staying in relatively warm water. Oceanography parameters commonly influencing the distribution of Euthynnus affinis are temperature, current, and salinity. The oceanography of Sunda Strait is influenced by water masses coming from the north that mainly originated from the Java Sea and water masses from the south mainly originated from Indian Ocean. The internal oceanography of Sunda Strait is also influenced by upwelling and monsoon as regional climate anomaly (ENSO and Indian Ocean Dipole Mode). This paper describes the influence of Dipole Mode (positive and negative event) and ENSO (El-Nino/La-Nina) to the catch dynamics of neritic tuna particularly in Sunda Straits waters. The results shown that regional climate anomaly influenced neritic tuna catch and its composition. The catches Euthynnus affinis in phase negative dipole mode or La-Nina were higher and dominated the catch composition of pelagic fishes of Sunda Strait. Similar situation also is showen by Scomberomorus commerson.

KEYWORDS: Neritic tuna, climate anomaly impact, Sunda Strait

INTRODUCTION

Longtail tuna (*Thunnus tonggol*), frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*), kawakawa (*Euthynnus affinis*), narrow-barred Spanish mackerel (*Scomberomerus commerson*) and Indo-Pacific king mackerel (*Scomberomerus guttatus*) are common species of *neritic tuna* caught in Indonesian waters. Muripto (2000) reported tongkol komo/kawakawa (*Euthynnus affinis*) and tenggiri (*Scomberomerus guttatus)* are commonly caught by mini purseiners operated in Sunda Straits where the fish catch as landed in Labuan, West Java.

Indian Ocean Tuna Commision/IOTC (2006) reported that *Euthynnus affinis*, inhabits coastal water and has preference staying in relatively warm water 18°- 29°C. This species forms school that appears down to 400 m depth. Oceanography parameters commonly influencing the distribution of *Euthynnus affinis* are temperature, current, and salinity (Hela & Laevastu, 1970). Gunarso (1985) also reported, *Euthynnus affinis* is susceptible to temperature and salinity from 0.03 ^{0}C and 0.02 ‰ espectively.

Labuan fishers operate two kinds of fishing gears namely mini purse seiners and danish seine (payang) both are operating on daily basis. The mini purse seiner is for night fishing while danish seine is day the fishing. Both fleets have relatively similar fishing ground and the area spreads from Banten coast to the south within the depth of 200 m depending to the seasons (Muripto, 2000).

Current information is limited to enable to adresses the influence of regional climate anomaly on fisheries resource specifally for the neritic tuna in Indonesian water. This paper describes the influence of *Dipole Mode* (positive and negative event) and ENSO (El-Nino/La-Nina) on the cacth dynamics of *neritic tuna* particularly in Sunda Straits for the periode of 1994 to 2009.

MATERIALS AND METHODS

Research was conducted in Sunda Strait Eastern part of Indian Ocean, geographically is located whithin 102.5^0 - 108.0^0 E and 4.5^0 - 7.5^0 S (Figure 1).

Regional climate anomaly that influence internal condition of Sunda Strait oceanography is El-Nino/La-Nina (ENSO) and Indian Ocean Dipole Mode/IOD (Samsudin *et al*, 2003). El-Nino/La-Nina events from 1994 to 2010 are showing in the following map (Figure 2) and Table 1.

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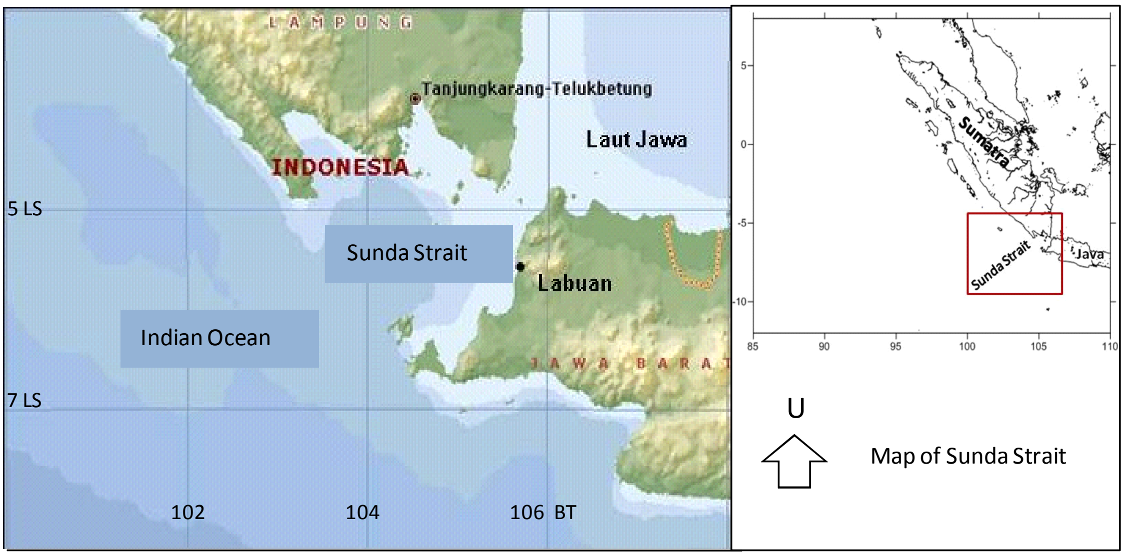


Figure 1. Research area located in Sunda strait.

Table 1. Event of Dipole Mode and its association with ENSO (El-Nino/La-Nina)

DIPOLE MODE		Association	ENSO		NORMAL	YEAR
Positive	Negative		El-Nino	La-Nina		
strong		+	moderate			1994
				moderate		1995
	strong					1996
strong		*In-phase*	strong			1997
	moderate	+		moderate		1998
				moderate		1999
				weak		2000
					normal	2001
			moderate			2002
weak						2003
			weak			2004
				weak		2005
strong		+	weak			2006
weak		+		moderate		2007
weak						2008
			moderate			2009
				strong		2010
			weak			2011
			weak			2012

(Amri, 2012, JAMSTEC, 2012, BMKG, 2012)

Available data on *Euthynnus affinis* and *Scoromberomorus guttatus* catches were presented againts climate condition particularly in 1994 (IOD Positive (strong) + El-Nino (moderate)); 1995 (La Nina (moderate); 1996 (IOD Negative (Strong)); 1997 (IOD Positive (strong) *in-phase* El-Nino (strong)); 1998 (IOD Negative (moderate) + La Nina (moderate)); 1999 (La Nina (moderate)); 2000 (La Nina (weak)); 2001 (Normal); and 2002 (IOD positive (weak)+ El Nino (weak); and 2012 (El-Nino (weak). Catch data were compiled from fish auction II (TPI II) Labuan specifically monthly catch that landed by mini purse seiners and danish seiners from 1993 to 2003 as well as total catch data from 1994 to 2008. Climate anomaly (*dipole mode* and ENSO) is indicated from anomaly of Sea Surface Temperature (SST). Satellite image SST was gathered from thermal AVHRR (Advanted Very High Resolution Radiometer) sensor within 1994-2000 (http://poet.jpl.nasa.gov/) and MODIS (*Moderate Resolution Imaging Spectroradiometer*) sensor within 2001-2012 (http://gdata1.sci.gsfc.nasa.gov/). SST utilized by standard algorithm MODIS 11 µm NLSST Algorithm (http://nasa.gsfc.gov). Chlorophyll-a images capture from MODIS sensors (http://gdata1.sci.gsfc.nasa.gov/) and predicted base on algorithm OC3M (O'Reilly *et al*., 2000). Descriptive analysis is conducted to compare the catch pattern of *Euthynnus affinis* and *Scoromberomorus guttatus* particularly on years that climate anomaly occurs.

RESULTS

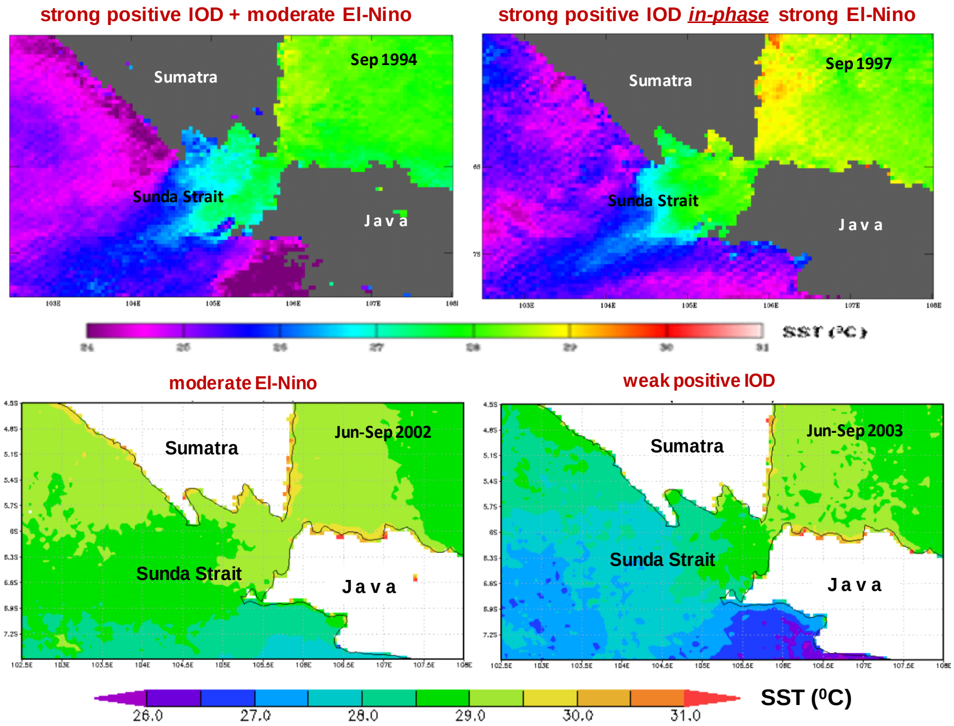
Oceanography Pattern of Sunda Strait

The oceanography of Sunda Strait is influenced by at least two water masses i.e: the water masses comes from the north that mainly originated from the Java Sea and water masses from the south mainly originated from the Indian Ocean. Water masses from the Java Sea have lower salinity and high temperature which influenced by rivers arrounds Java Sea while these from the Indian Ocean were more oceanic with high salinity and low temperature. The two water masses mixed in the central of the straits and its position depends on the strenght of the current of each water masses.The current from southern strait i.e South Java Current (Arus Pantai Selatan Jawa/APJ), South Equator Current (Arus Khatulistiwa Selatan (AKS)) and Monsoon Current (arus Musim (AM)), while the current from northern strait is dominated by Armondo (Arus Musim Indonesia). One in a while oceanography of Sunda Strait is also influenced by upwelling (Muripto *et al*. 2000; Hendiarti *et al* 2003) and monsoon as regional cimate anomaly (Samsudin, *et al*. 2003).

Sea Surface Temperature

Climate anomaly occured in 1994 (Positive strong IOD *in-phase* moderate El-Nino); 1997 (Positive strong IOD *in-phase* strong El-Nino); and 2006 (Positive strong IOD inphase weak El-Nino) there was water mass from upwelling in the middle and southern strait with high intensity. In this phase the temperature of water mass become much lower compare to its normal condition. The upwelling water mass with moderate intensity also occured in 2002 (moderate El-Nino); 2003 (weak postive IOD); 2004 (weak El-Nino); 2009 (moderate El-Nino); as well as 2011 and 2012 (weak El-Nino) (Figure 2).

In the contrary, during negative dipole mode and/or La-Nina, upwelling did not occur and commonly the water masses have higher SPL disribution than during normal condition. This condition was recorded and occured in year of 1995 (weak La-Nina); 1996 (negative strong IOD); 1998 (negative moderate IOD in-phase moderate La-Nina); 1999 (weak La-Nina); 2000 (La-Nina lemah); 2005 (weak La-Nina); and 2010 (strong La-Nina) (Figure 3). 2001 was a normal year and no influence from IOD and/or ENSO on the Sunda Strait water (Figure 4).



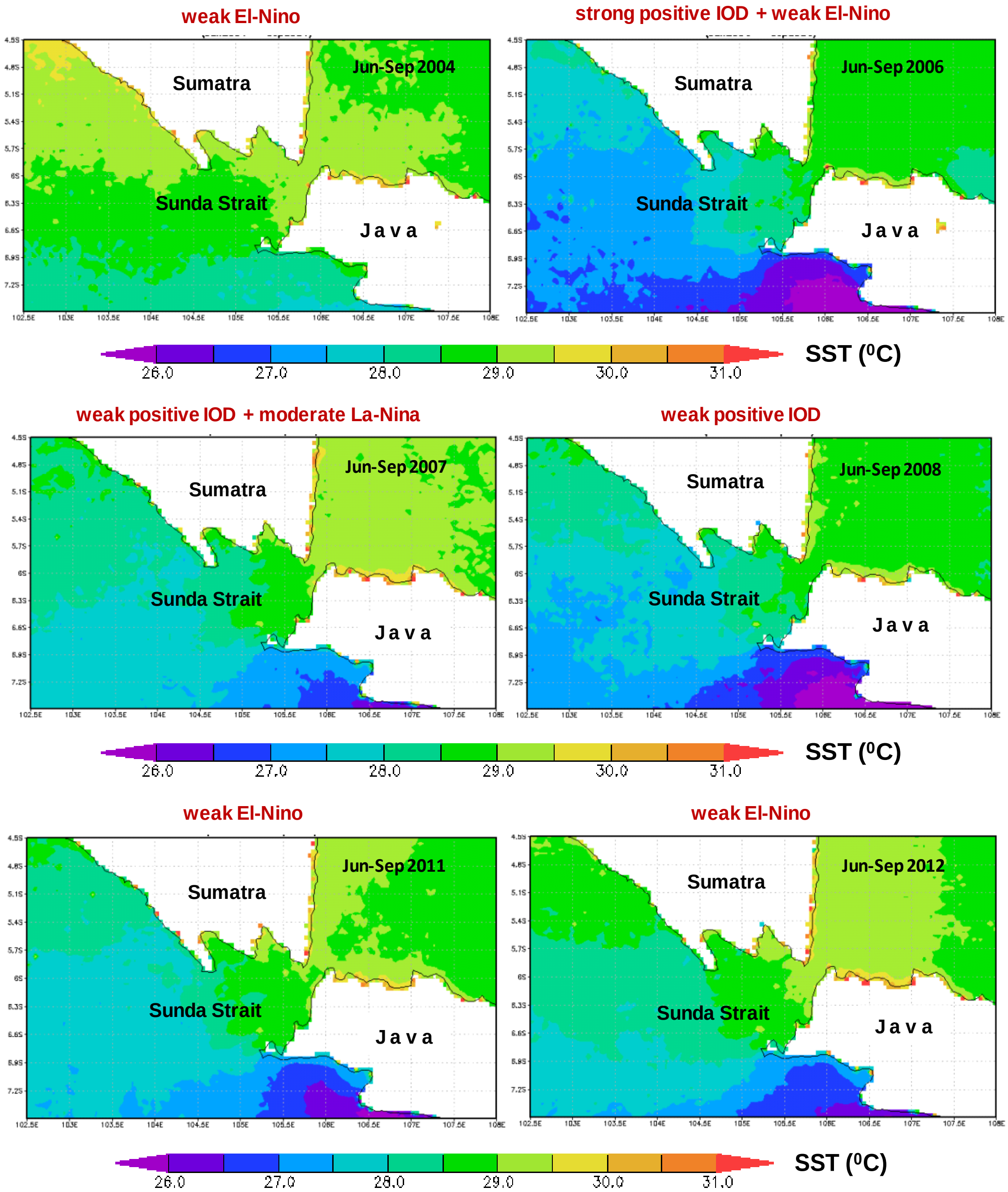


Figure 2. Images of SST on IOD positive and/or El-Nino event (1994-2012).

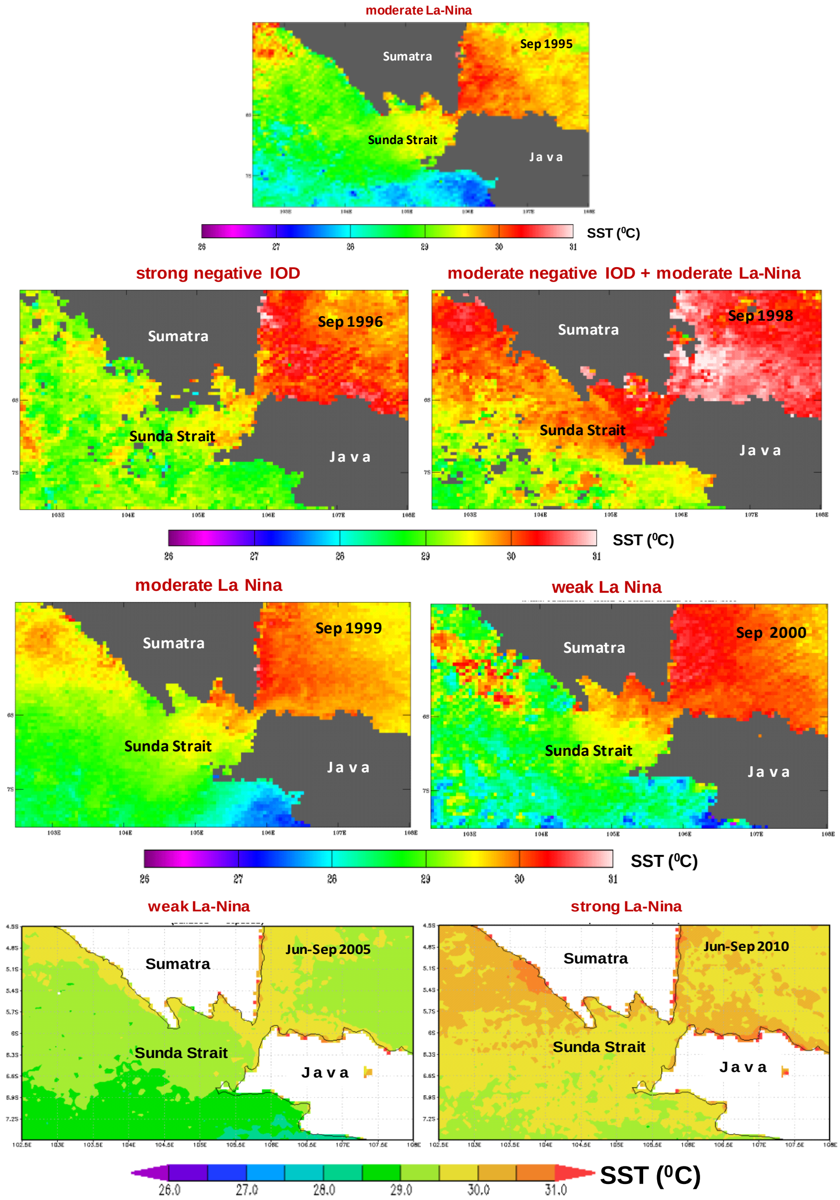


Figure 3. Images of SST on IOD negative and/or La-Nina event (1995-2010).

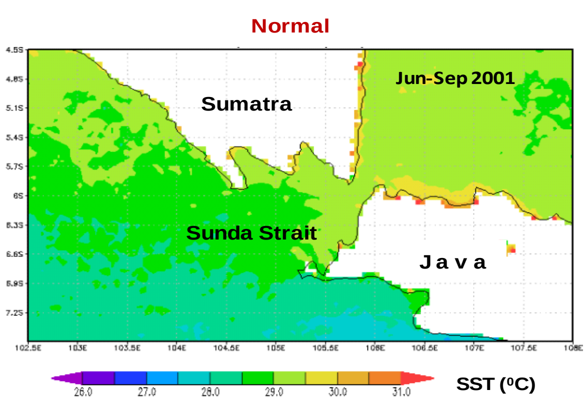


Figure 4. SST Image of Sunda Strait during Normal condition (no dipole mode, no ENSO) (2001).

The SST distribution from each period from 1994-2012 is presented in Table 2 and its fluctuation is also shown in the graph (Figure 5). The lowest average of SPL distribution occured in the phase of strong positive IOD inphase with El-Nino year of 1994, 1997, and 2006 with respective temperature of 27.97 ^{0}C (in-phase with moderate El-Nino), 28.47 ^{0}C (in-phase with strong El-Nino) and 28,77 ^{0}C (in-phase with weak El-Nino). The higher average of SST distribution occured during negative IOD or La-Nina phase with temperature range of 30.49-31.29 ^{0}C. The highest SST occur and found in the phase of strong negative IOD 1996 (31.02 ^{0}C) and moderate negative IOD inphase with moderate La-Nina 1998 (31.29 ^{0}C). The average of SST distribution in the normal phase (2001) was 30.14 ^{0}C.

Sea Surface Chlorophyll

Chlorophyll-a distribution in the period of IOD positive or El-Nino higher than in the period of negative IOD and La-Nina or in normal phase. High distribution of chlorophyll-a in the period of positive dipole mode and El-Nino was due to the occurrence of intensive upwelling during that time. The average of SST and chlorophyll-a distribution from 1997-2009 is presented in Figure 6.

Table 2. SST range and average value by phenomenon of regional climate anomaly.

Phenomenon (Years)		SST (0C)	
		Range	Average
Positive IOD/El- Nino	Strong Positive IOD + moderate El-Nino (1994)	26.40 - 28.98	27.90
	Strong Positive IOD in-phase strong El-Nino (1997)	28.50 - 29.80	28.47
	Moderate El-Nino (2002)	29.50 - 29.98	29.65
	Weak positive IOD (2003)	28.58 - 29.73	29.23
	Weak El-Nino (2004)	28.20 - 29.93	29.14
	Strong positive IOD + weak El-Nino (2006)	28.88 - 29.02	28.77
	Weak positive IOD + moderate La-Nina (2007)	28.98 - 29.93	29.40
	Weak positive IOD (2008)	29.03 - 31.13	30.09
	Weak El-Nino (2011)	28.96 - 31.00	30.24
	Weak El-Nino (2012)	28.93 - 31.09	30.26
Negative IOD/La- Nina	Moderate La Nina (1995)	29.23 - 31.65	30.49
	Strong negative IOD (1996)	29.48 - 31.88	31.02
	Moderate negative IOD vs moderate La Nina (1998)	29.62 - 32.33	31.29
	Moderate La-Nina (1999)	29.03 - 31.58	30.51
	Weak La-Nina (2000)	29.25 - 31.32	30.28
	Weak La-Nina (2005)	29.48 - 32.22	30.63
	Strong La-Nina (2010)	29.49 - 31.00	30.92
Normal	Normal (2001)	29.18 - 31.01	30.14

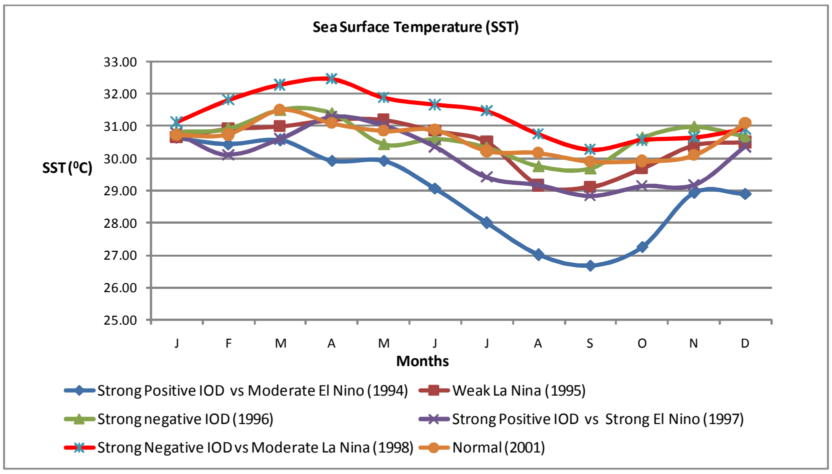


Figure 5. Monthly fluctuation of SST.

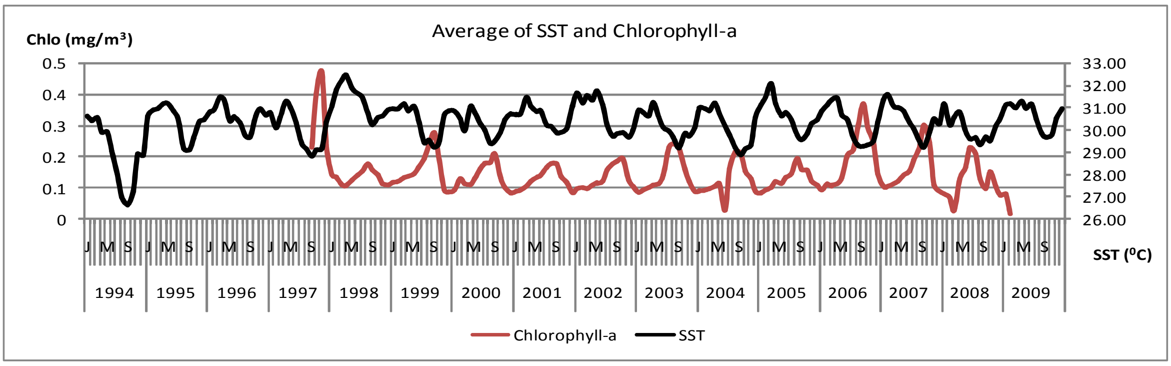


Figure 6. Average value of SST and Chlorophyll-a 1994-2009 in Sunda Strait.

Looking at the monthly distribution and fluctuation of chlorophyll-a when climate anomaly occurred (Figure 7), revealed that in the period of strong positive dipole mode 1997 and 2006 the distribution of chlorophyll-a was very high, on the other hand during negative phase of dipole mode and La-Nina the distribution of chlorophyll-a was very low.

DISCUSSION

Annual catch of small pelagic and neritic tuna from Labuan during 1993-2008 is presented in (Figure 8). The catch of small pelagic was very high in 1994 (strong phase positive IOD *inphase* moderate El-Nino) as well as intensive upwelling (low SST and high cholophyll-a) and lower in the period of negative dipole mode and La-Nina (high SST and low cholophyll-a). Different pattern showed by the catches of neritic tuna where high catch in the period of negative IOD and La-Nina (high SST and low cholophyll-a) and lower in the period of positive IOD and El-Nino (low SST and high cholophyll-a).

Figure 9 presents the highest catch of *Euthynnus affinis* occur in in the period of strong negative IOD associated with moderate La-Nina (1998), followed by the normal period (2001) and moderate La-Nina period (1999). Monthly catches fluctuation showed diferent pattern of inter phase.

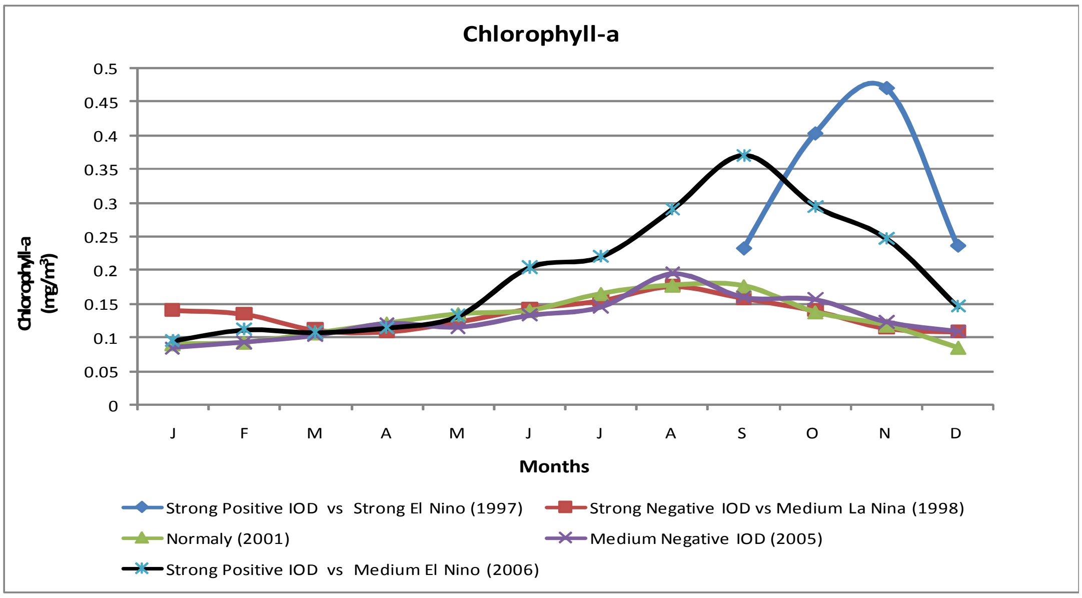


Figure 7. Monthly fluctuation of Chlorophyll-a.

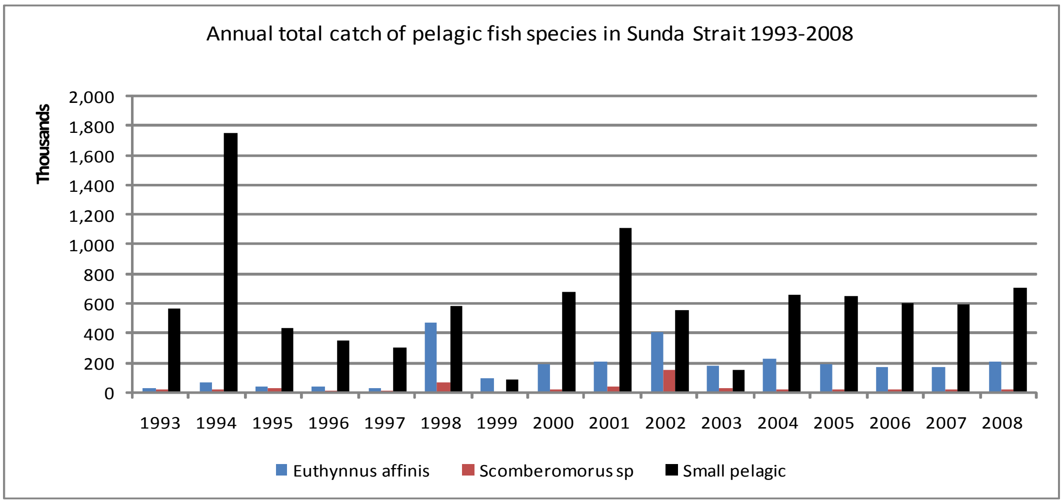


Figure 8. Annual total catch of small pelagic species and neritic tuna in Labuan 1993-2003.

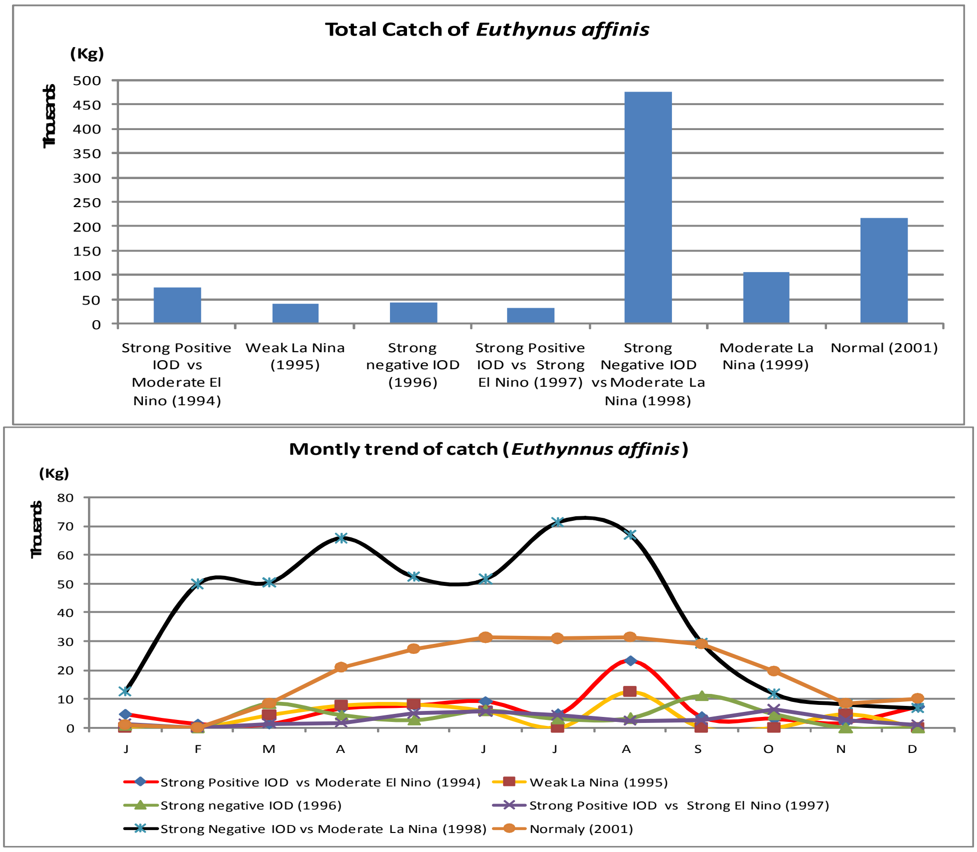


Figure 9. Annual total catch (above) and monthly fluctuation catch (below) of *Euthynnus affinis* in Labuan by phenomenon years.

The highest catch of *Scoromberomorus spp* also occur in strong negative IOD period of 1996 and 1998, but low in the period of positive dipole mode/El-Nino (Figure 10 and Figure 11). There was a similar trend of monthly catches in 1996 and 1998 but with different intensity whithin each month.

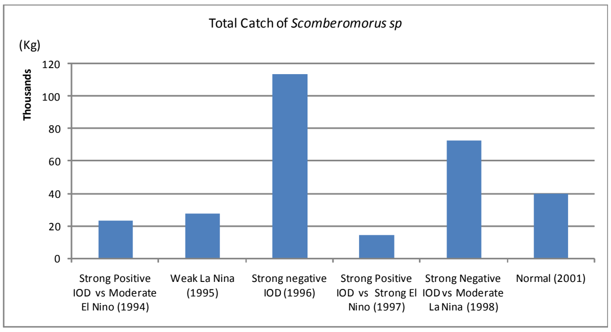


Figure 10: Annual total catch of *Scomberomorus comerson* in Labuan assosiated with climate anomally.

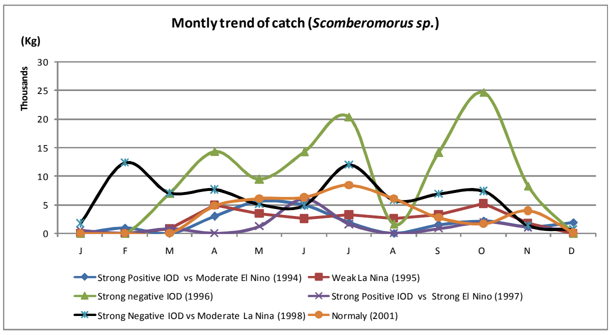


Figure 11: Monthly fluctution catch (below) of *Scomberomorus comerson* in Labuan assosiated with anomally phenomena.

Different catch composition occur among dipole mode positive/El-Nino phase, dipole mode negatif/La-Nina phase and normal phase, and its correlation with ocean phenomenon (Table 3). Lowest catch proportion of tongkol (*Euthynnus affinis*) occur in dipole mode positive/El-Nino phase i.e. 8% (1994) and 9% (1997) while *Scoromberomorus sp* was 1% (1994) and 4% (1997) (Figure 12). The highest catch proportion of tongkol (*Euthynnus affinis*) occur within dipole mode negative/La-Nina phase i.e 42% (1998) (strong negative IOD *inphase* moderate La-Nina) and 53% (1999) (moderate La-Nina) (Figure 13). In the normal phase the proportion of tongkol (*Euthynnus affinis*) was 16% (2001) (Figure 14).

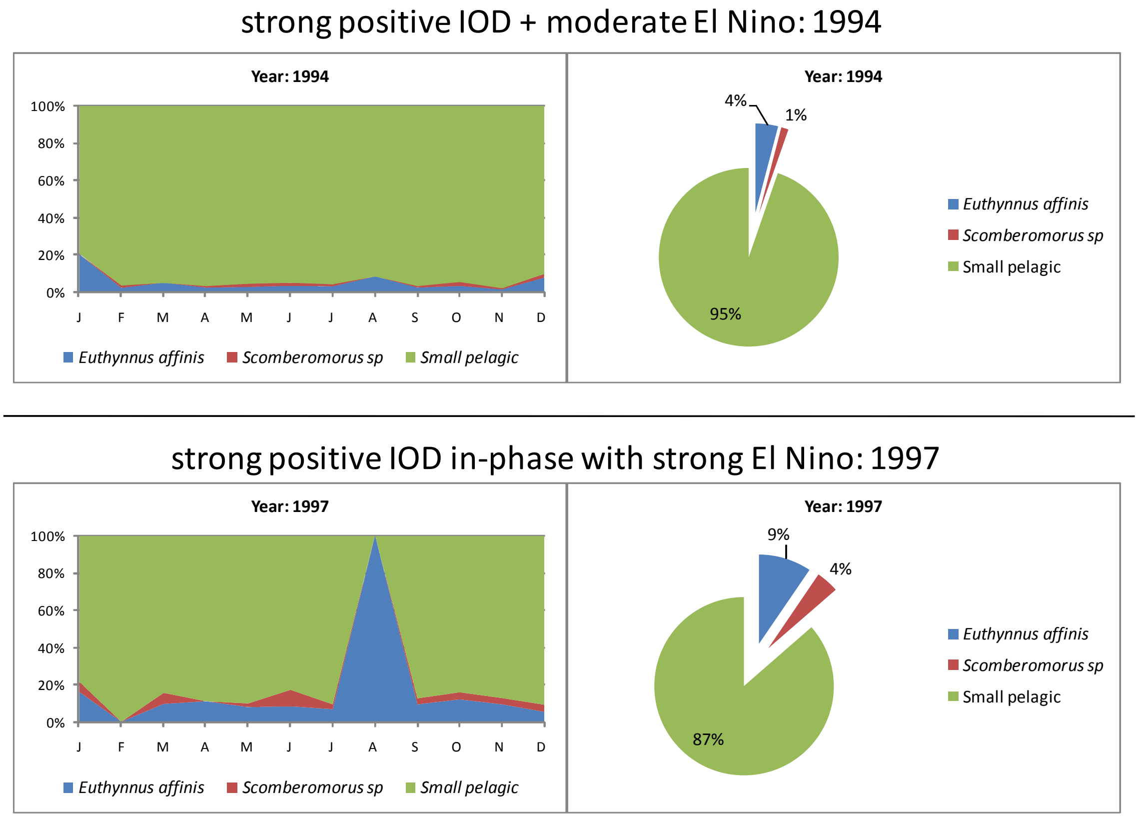


Figure 12: Catch composition of neritic tuna caught by mini purse seine in Labuan during positive Dipole Mode and El-Nino event 1994 and 1997.

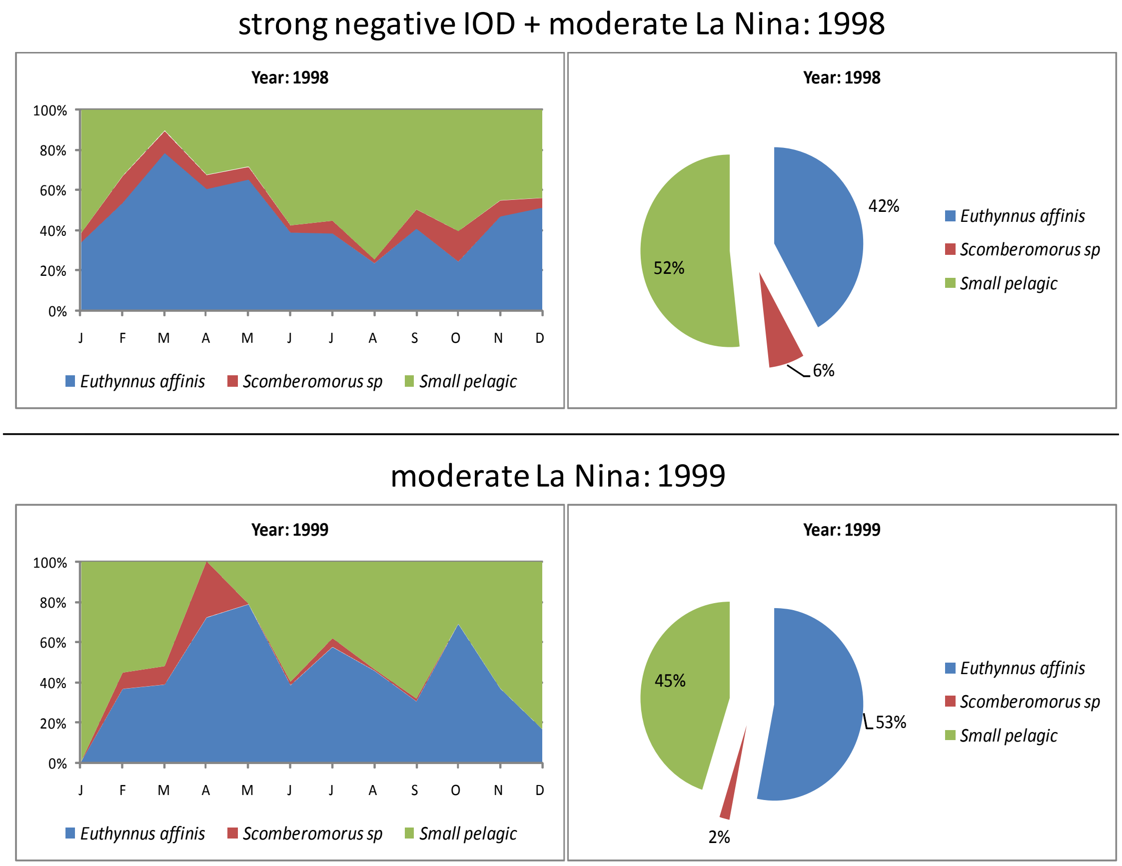


Figure 13: Catch composition of neritic tuna caught by mini purse seine in Labuan during negative Dipole Mode and La-Nina event 1998 and 1999.

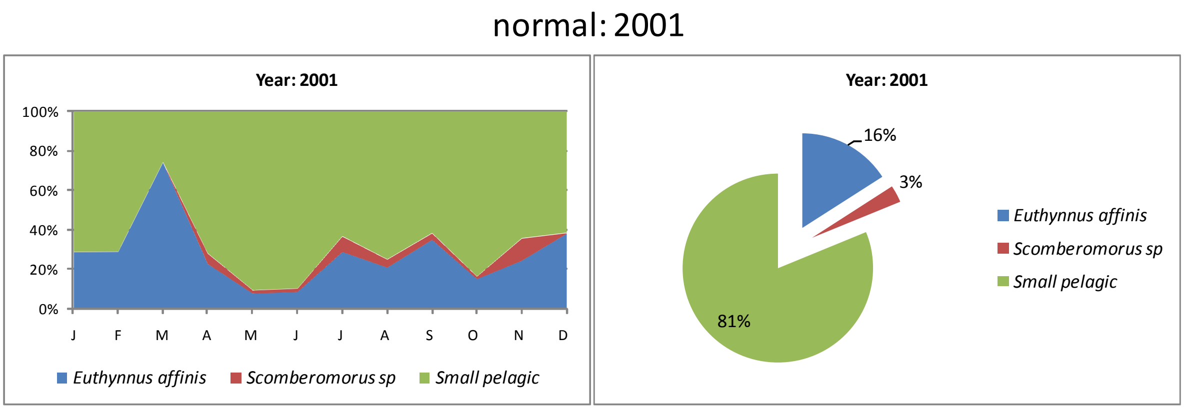


Figure 14: Catch composition of neritic tuna caught by mini purse seine in Labuan on Normal 2001

Table 3. Characteristic of neritic tuna (Euthynnus affinis) and ocean phenomenan by climate anomaly

Species	Climate Anomaly	Catch Characteristic	Catch Proportion	Ocean phenomena
Euthynnus affinis	Strong Positive IOD + Moderate El Nino (1994)	Minimum	Low (8%)	cold surface waters, high salinity and high nutrient (upwelling)
	Strong Positive IOD in-phase Strong El Nino (1997)	Minimum	Low (9%)	cold surface waters, high salinity and high nutrient (upwelling)
	Strong Negative IOD + Moderate La Nina (1998)	Maximum	High (42%)	warm surface waters, low salinity and low nutrient, surface waters transpor from rivers
	Moderate La-Nina (1999)	Maximum	High (55%)	warm surface waters, low salinity and low nutrient, surface waters transpor from rivers
	Normaly (2001)	Moderate	Moderate (16%)	moderately warm surface waters, and moderately low nutrient

CONCLUSION

1. Significant difference of SST distribution in the Sunda Strait during regional climate anomaly occurs during positive dipole mode and during El-Nino the SST distribution tend low but higher and warm during in the period of negative dipole mode or La-nina event
2. The catches of neritic tuna (*Euthynnus affinis)* in the period of negative dipole mode or La-Nina was higher and dominate the composition of pelagic catchs in the Sunda Strait. SST distribution in this period was higher and thus the *Euthynnus affinis* prefer to in live warmer water. This might cause the high catch during this period. Similar condition was also shown by *Scomberomorus commerson* as this species is a more coastal.
3. Lower salinity resulted from high level of rain the period of negative dipole mode or La-Nina wich may affect the abundance of some neritic tunas in the Sunda Strait.
4. The catches of neritic tuna from Sunda Straits that landed in the PPP Labuan should in future be recorded by gear and by species as well as by fishing ground to enable on the have better accuracy and precision in the analysis.

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