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Analyses of catch, effort and nominal CPUE data of frigate tuna (*Auxis thazard*) and kawakawa (*Euthynnus affinis*) caught by recreational fishers in Kenya

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1. Introduction

Catch Per Unit Effort (CPUE) is important information used to learn the rough trends the stock abundance and also to conduct the stock assessment. However, the quality of CPUE should be good, otherwise should not be used. In this paper, using available historical catch and effort data (1990-2009), we attempted nominal CPUE analyses for neritic tuna (Frigate tuna *Auxius* spp and Kawakawa *Euthynnus affinis* and) caught by the recreational fisheries in Kenya. We attempted nominal CPUE analyses using the aggregated data to month and year. In the nearby future we plan to attempt CPUE standardization using finer scale data. It is our wish to contribute these catch and effort data to the IOTC Secretariat, so that IOTC community can share the data, which is one of objectives of this study.

2. Data

We used catch and effort data set (1990-2009) available in the Malindi sport fishing club (Fig. 1). The data for 1995, 1996, 2002, 2003, and 2009 are incomplete. In the data set, monthly fishing effort (boat*fishing days) and monthly catch (number and weight in Kg) by species and boat are available. Catch data are available for 3 species (frigate tuna, kawakawa and narrow-barred Spanish mackerel, *Scomberomorus commerson*).

In this paper we worked for frigate tuna, kawakawa. For narrow-barred Spanish mackerel, there is a separate paper on this species, i.e., “Preliminary analysis of catch trends of narrow-barred Spanish mackerel *Scomberomorus commerson* caught from recreational trolling line fisheries in Kenya” by P.N. Wekesa and S.W. Ndegwa (IOTC-2013-WPNT03- 28).

3. Fishing grounds

The fishing grounds used by the recreational fishers in Kenya are along the Northern Kenya banks as indicated in the figure below.

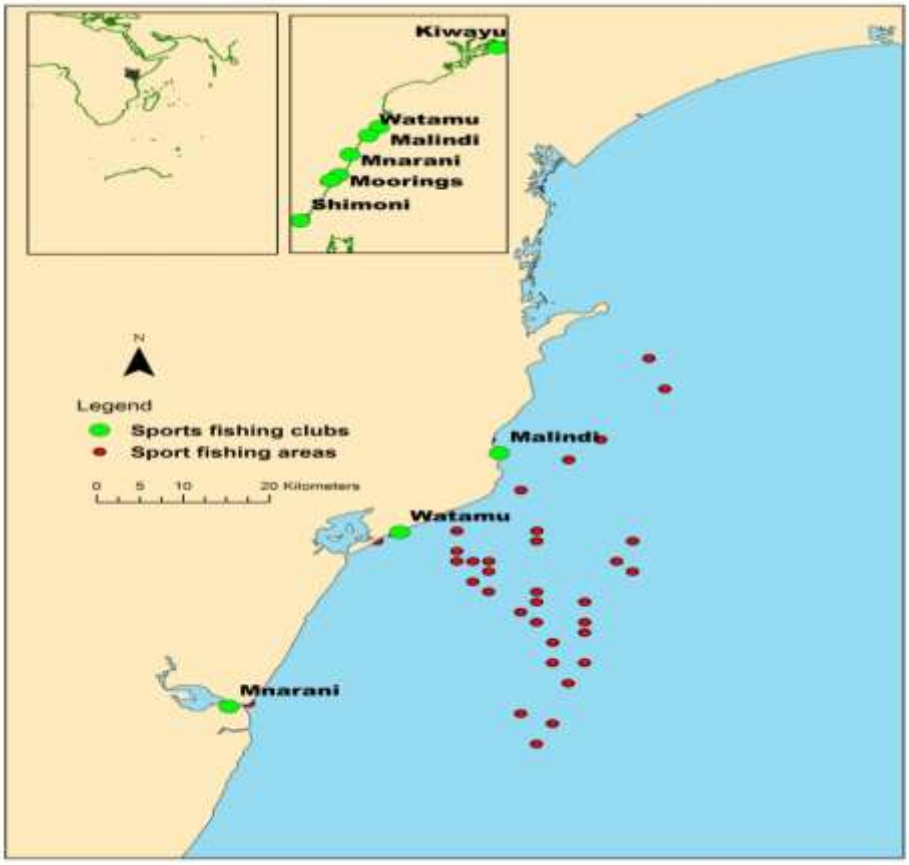


Fig. 1 Locations of sports fishing club and fishing areas.

4. Catch and effort analyses

Fishing effort

Trends of annual fishing efforts (boat*fishing days) and also number of boats operated are depicted in Fig. 2. The figure suggests that in the first half 1990's (1990-1994), fishing efforts were high, but afterwards during 1997-2007, the level of the fishing efforts decreased and stabilized. But after 2008, fishing efforts sharply decreased. This was most probably caused by pirate activates that was intensified from 2008. For the detail discussion on piracy activities, refer to the paper by AL-Kiyumi et al (IOTC-2013-WPNT03-___), "Preliminary kawakawa (*Euthynnus affinis*) stock assessment by ASPIC using standardized CPUE of drift gillnet fisheries in Sultanate of Oman". Monthly fishing efforts (boat*fishing days) are shown in Table 1 and Fig.2 respectively, which shows strong seasonality, i.e., major fishing are conducted mainly during NE monsoon season (October to March).

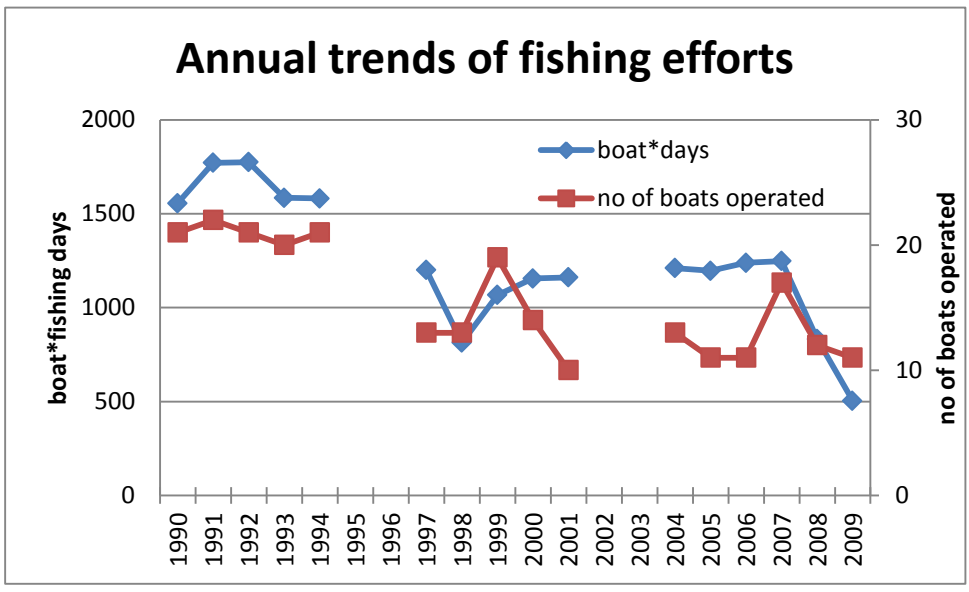


Fig. 2 Trends of fishing effort (boat*fishing days) and number of boats operated

Table 1 Monthly Effort statistics (fishing*boat days) (1990-2009)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**total**
1990	236	261	165	37	3	4	20	92	90	203	242	203	**1,556**
1991	275	239	145	37	6	20	32	144	114	278	237	244	**1,771**
1992	307	297	148	45	14	7	30	108	95	252	231	241	**1,775**
1993	223	294	185	43			13	70	79	197	267	214	**1,585**
1994	264	280	182	36			19	61	80	242	209	208	**1,581**
1995*	239	280											**519**
1996*												176	**176**
1997	182	207	131	24			22	124	84	183	162	81	**1,200**
1998	125	103	54	4	2	3	11	44	118	117	122	110	**813**
1999	135	196	56	12	4	13	21	98	149	145	134	104	**1,067**
2000	176	231	112	7			45	76	125	91	184	108	**1,155**
2001	196	240	121	12	4	6	41	69	57	136	176	103	**1,161**
2002*	161	156	118	22	9	14							**480**
2003*												157	**157**
2004	195	201	127	32	4	7	16	81	43	175	193	137	**1,211**
2005	141	194	123	30	1	8	21	103	97	167	177	134	**1,196**
2006	164	185	157	23	6	10	24	76	64	204	273	53	**1,239**
2007	210	220	143	35	7	8	29	73	80	140	155	148	**1,248**
2008	128	156	90	23	4	3	16	45	50	105	113	100	**833**
2009	180	190	102	21	4	7							**504**
Total	**3,537**	**3,930**	**2,159**	**443**	**68**	**110**	**360**	**1,264**	**1,325**	**2,635**	**2,875**	**2,521**	**21,227**

Note (*) incomplete

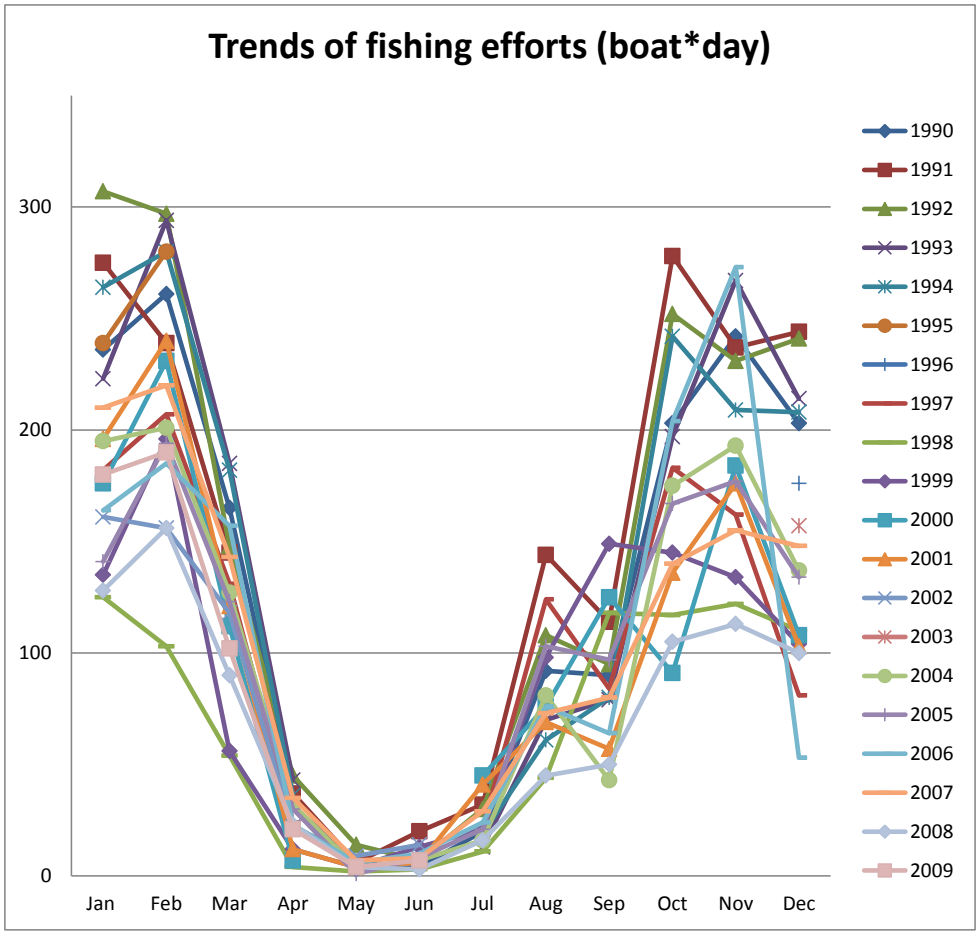


Fig. 3 Monthly trends of fishing efforts (1990-2009)

Note Data for 1995, 1996, 2002, 2003 and 2009 is incomplete.

Catch

Annual frigate and kawakawa catch is shown in Fig. 4. Frigate catch has been stable less than 1,000 tons during 1990-2004. But in 2005, it suddenly jumped to the 2,000 tons level, afterwards sharply decreased to the 400 tons level. Kawakawa catch largely fluctuated between around 1,000-3,000 tons in 1990-2009, but in 2009 it sharply dropped to the 300 tons. Sharp drops of both species could have been caused by intensified piracy activities in 2008 as discussed in previous effort section.

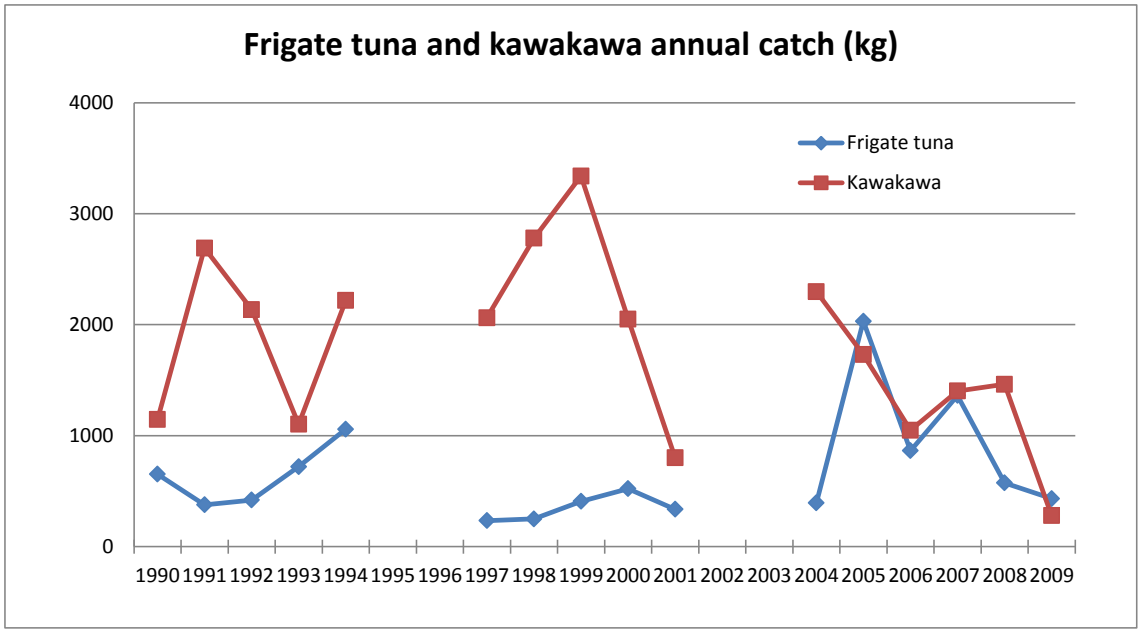


Fig. 4 Trends of annual frigate tuna and kawakawa catch (1990-2009)

Monthly frigate tuna and kawakawa catch (number) tables and their trends are shown in Tables 2-3 and Figs. 5-6 respectively. From these Tables and Figures we understand that catch are highly seasonal, i.e., the recreational fishing are mainly conducted during the NW monsoon season (October-March). Kawakawa catch is about 3 times higher than frigate catch in average between 1990-2009.

Table 2 Monthly **frigate tuna catch** statistics (number) (1990-2009)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	total
1990	348	97	159	24	0	0	0	2	5	7	5	6	**653**
1991	14	114	82	28	3	20	22	27	7	4	12	44	**377**
1992	48	91	22	86	1	0	3	6	6	18	13	126	**420**
1993	413	45	19	13	0	0	0	4	2	25	42	158	**721**
1994	346	470	175	16	0	0	10	8	5	4	5	19	**1,058**
1995*	6	38	0	0	0	0	0	0	0	0	0	0	**44**
1996*	0	0	0	0	0	0	0	0	0	0	0	12	**12**
1997	5	24	68	5	0	0	42	23	10	1	20	36	**234**
1998	11	7	0	2	0	1	0	4	84	35	17	89	**250**
1999	40	35	80	24	15	16	23	110	49	1	3	12	**408**
2000	65	138	109	6	0	0	57	33	10	0	3	101	**522**
2001	44	80	33	18	7	20	8	2	6	58	11	49	**336**
2002*	523	141	28	0	15	11	0	0	0	0	2	0	**720**
2003*	0	0	0	0	0	0	0	0	0	0	0	10	**10**
2004	90	122	36	0	0	0	0	2	0	2	4	138	**394**
2005	308	977	346	8	0	1	20	211	69	35	34	22	**2,031**
2006	24	163	87	26	12	43	82	206	124	51	4	43	**865**
2007	293	616	221	53	0	10	3	19	14	6	38	89	**1,362**
2008	29	21	67	2	0	5	93	219	129	2	2	5	**574**
2009	32	165	113	26	31	66	0	0	0	0	0	0	**433**
total	**2,639**	**3,344**	**1,645**	**337**	**84**	**193**	**363**	**876**	**520**	**249**	**215**	**959**	**11,424**

Note (*) incomplete

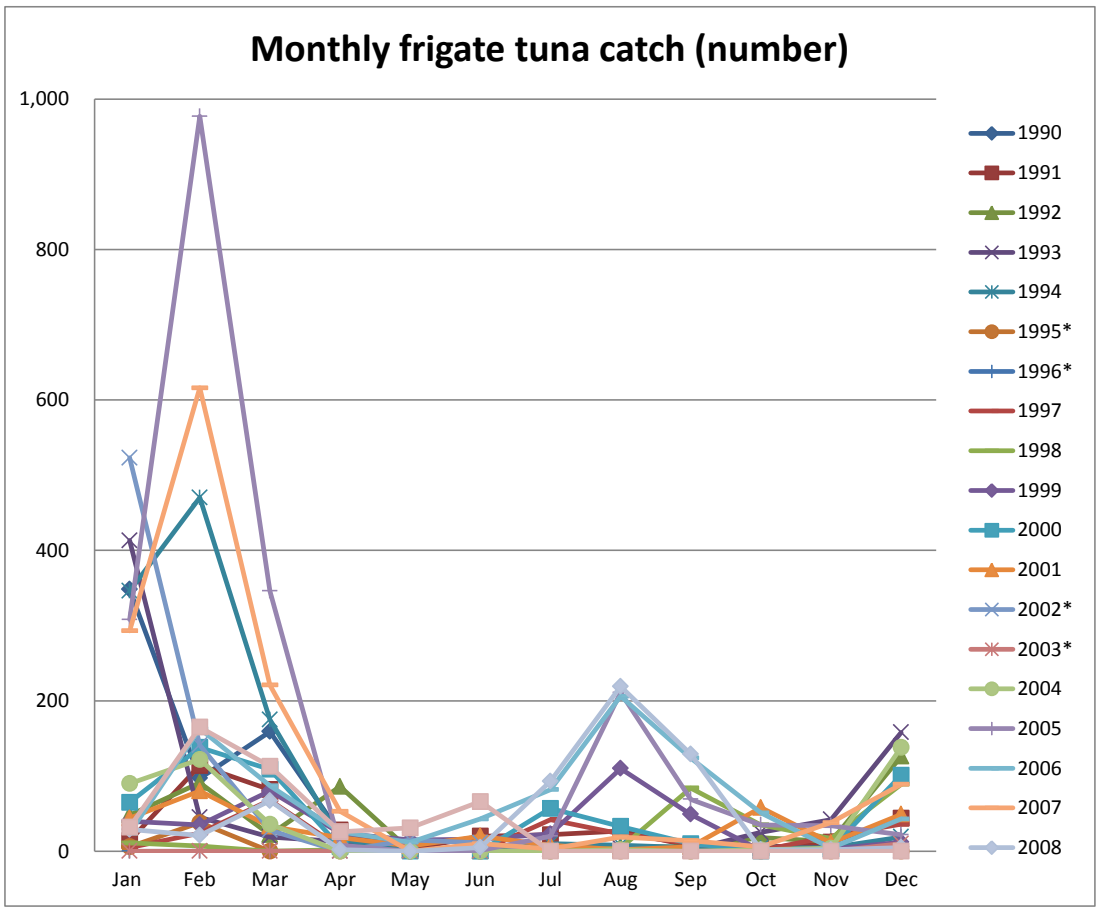


Fig. 5 Monthly trends of frigate tuna catch (1990-2009)

Note Data for 1995, 1996, 2002 and 2003 is incomplete.

Table 3 Monthly **kawakawa catch** statistics (number) (1990-2009)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**total**
1990	82	193	213	7	0	7	27	45	6	35	62	469	**1,146**
1991	710	108	111	69	8	59	57	100	13	220	816	420	**2,691**
1992	546	511	128	106	30	16	58	187	33	52	107	362	**2,136**
1993	174	212	167	100	0	0	28	22	8	13	84	295	**1,103**
1994	191	516	474	142	0	0	108	47	8	14	82	638	**2,220**
1995*	456	519	0	0	0	0	0	0	0	0	0	0	**975**
1996*	0	0	0	0	0	0	0	0	0	0	0	1,188	**1,188**
1997	169	390	872	119	0	0	116	245	32	15	51	54	**2,063**
1998	138	92	28	2	1	12	42	126	447	282	205	1,405	**2,780**
1999	1,192	559	292	50	75	136	108	457	136	39	94	202	**3,340**
2000	312	349	436	8	0	0	297	305	94	44	37	169	**2,051**
2001	61	211	131	11	16	30	13	34	44	67	65	119	**802**
2002*	206	88	42	16	24	66	0	0	0	0	0	0	**442**
2003*	0	0	0	0	0	0	0	0	0	0	0	83	**83**
2004	302	785	220	50	31	48	19	93	17	45	77	611	**2,298**
2005	498	263	206	35	3	58	109	256	68	23	102	110	**1,731**
2006	69	193	83	42	16	75	126	132	92	90	58	73	**1,049**
2007	18	34	41	36	21	20	44	163	24	41	269	691	**1,402**
2008	340	403	230	6	1	32	97	234	79	8	22	11	**1,463**
2009	53	78	83	18	20	29	0	0	0	0	0	0	**281**
total	**5,517**	**5,504**	**3,757**	**817**	**246**	**588**	**1,249**	**2,446**	**1,101**	**988**	**2,131**	**6,900**	**31,244**

Note (*) incomplete

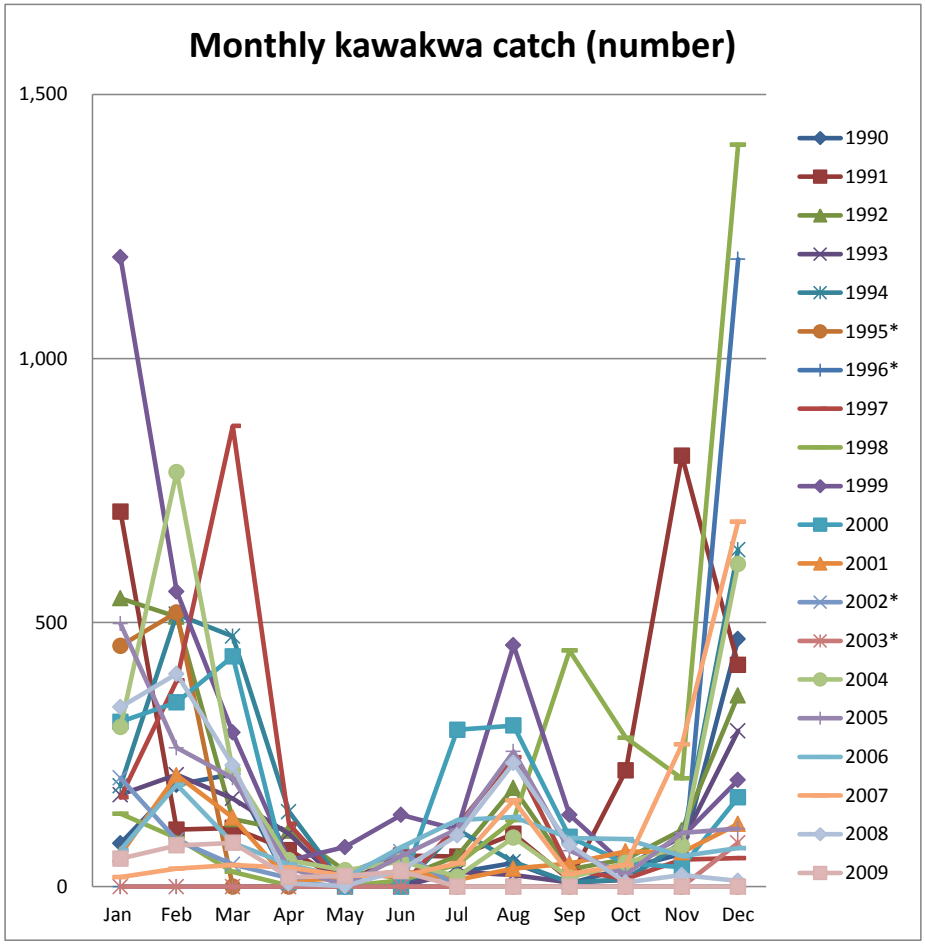


Fig. 6 Monthly trends of kawakawa catch (1990-2009)

Note Data for 1995, 1996, 2002, 2003 and 2009 is incomplete.

5. Nominal CPUE analyses

Definition

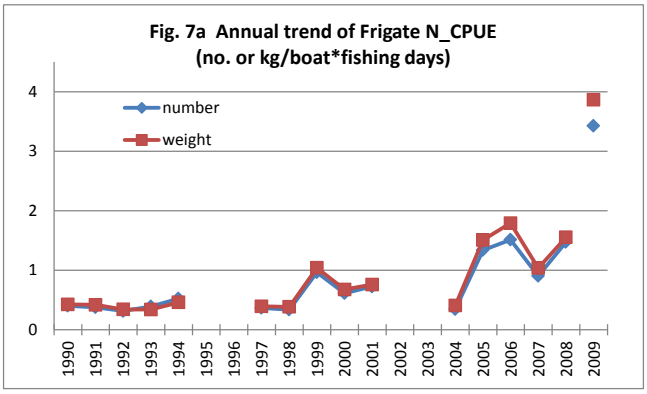
We computed nominal CPUE using available fishing effort (boat*fishing hours). As for catch we use also available data in number and in weight (kg). Then CPUE is defined as below:

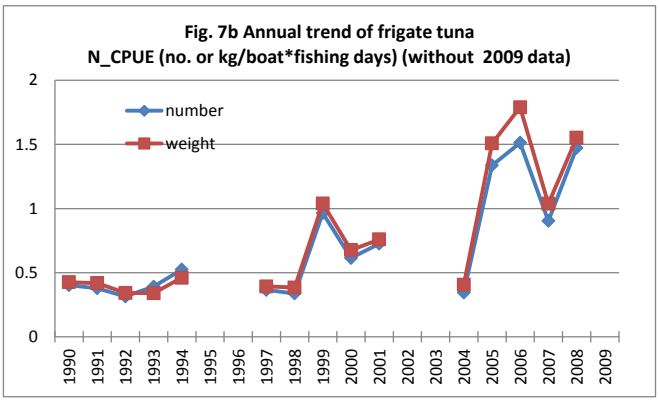
*Nominal CPUE (N_CPUE) = catch (number or Kg)/fishing effort (boat*fishing days)*

We did not include the catch and effort data in 1995-1996 and 2002-2003 as they are incomplete.

Frigate tuna

Fig. 7a shows the resultant annual N_CPUE trends of frigate tuna. The annual N_CPUE in 2009 (Fig. 7a) is too high and likely unrealistic. We will investigate this problem later. For now, we re-plot the N_CPUE excluding the 2009 point (Fig. 7b).





Frigate tuna annual N_CPUE shows the increasing trend. The annual frigate tuna catch also shows the increasing trends (Fig. 2). Normally catch and CPUE are negatively correlated, but for this case, both show the increasing trend (positively correlated) (Fig. 8) except during 2005-2008 where we could observe the negative correlation. As frigate tuna catch and N_CPUE are not well corresponding, it is implied that N_CPUE may not reflect the real situation. However, we have some reservation on this implication as we analyzed the catch and effort data only from small area comparing to the much larger area where frigate tuna migrates. That may be why both catch and N_CPUE are positively auto-correlated.

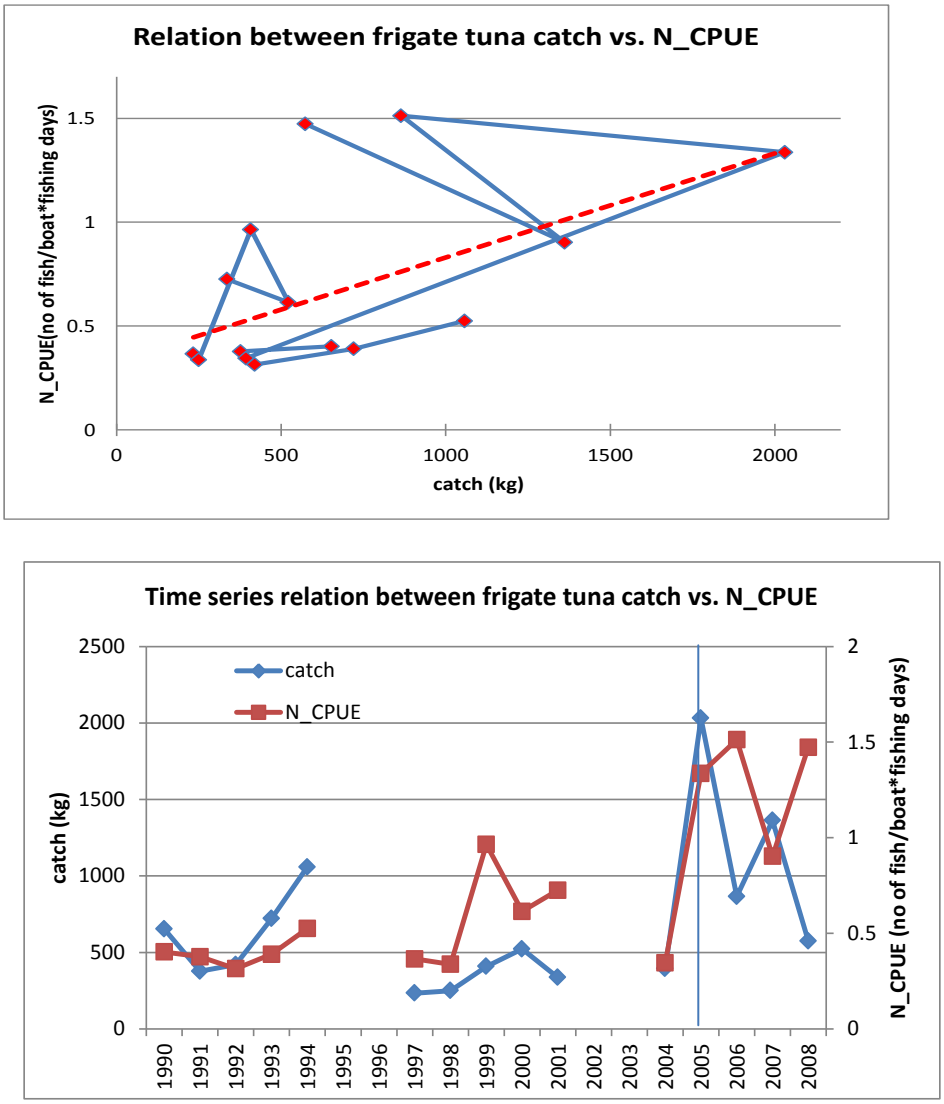


Fig. 8 Relation between frigate tuna annual catch vs. N_CPUE *(above) scatter plots and (below) time-series*

Kawakawa

We analyzed kawakawa N_CPUE data in the same way as for frigate tuna. Fig. 9 shows kawakawa annual N_CPUE, which shows the increasing trend to 1999, then afterwards decreasing trend to 2009. We also investigated relations between catch vs. N_CPUE. Similar to the case of frigate tuna, catch and N_CPUE are positively correlated. Thus N_CPUE may not represent the real abundance. But again, it is difficult to judge only from this information.

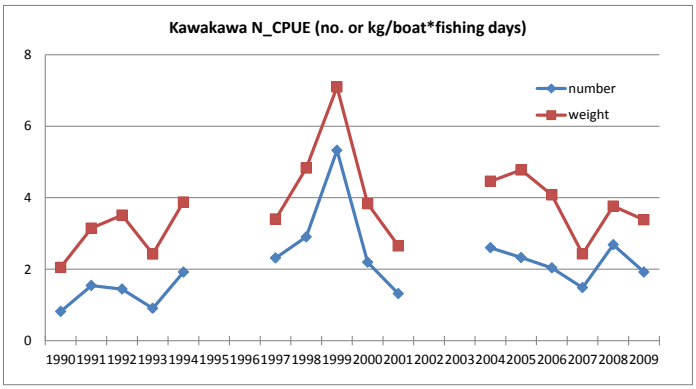


Fig. 9 Annual trend of kawakawa N_CPUE

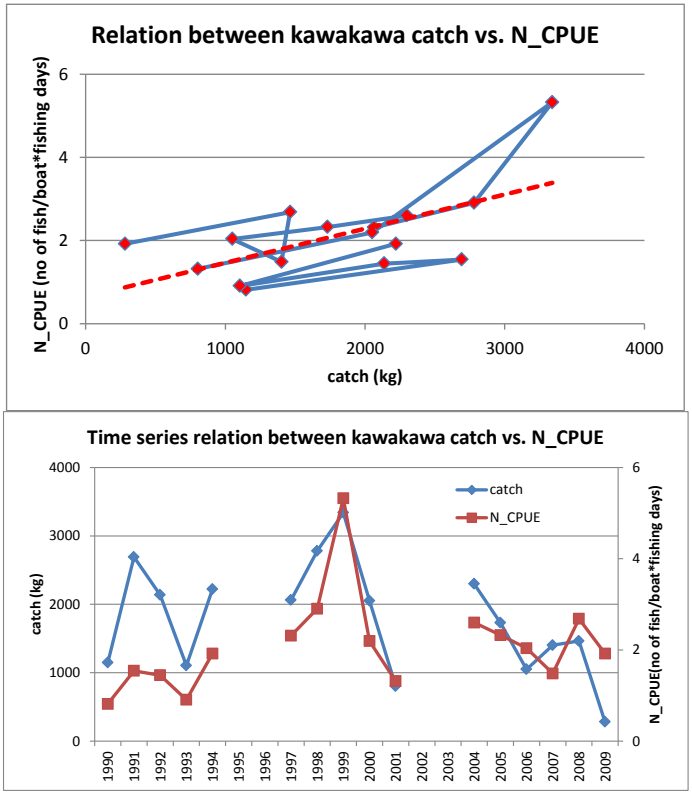


Fig. 8 Relation between frigate tuna annual catch vs. N_CPUE
(above) scatter plots and (below) time-series