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A COMPARISON OF TWO BLUE-DYED BAIT TYPES FOR REDUCING INCIDENTAL CATCH OF SEABIRDS IN THE EXPERIMENTAL OPERATIONS OF THE JAPANESE SOUTHERN BLUEFIN TUNA LONGLINE

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A comparison of two blue-dyed bait types for reducing incidental catch of seabirds in the experimental operations of the Japanese southern bluefin tuna longline

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Abstract

The use of blue-dyed bait is one of the effective mitigation measures to reduce incidental catch of seabirds. However, the effect of the blue-dyed bait may be changed by bait types such as squid and fish. The effects of blue-dyed squid and fish baits for reducing incidental catch of seabirds were examined by the Japanese longline fishery survey cruises. The surveys were conducted by Matsuei-maru No.3 in 2001, Fukuseki-maru No.33 in 2002 and Fukuryu-maru No.21 in 2003 off South Africa in the Southern Ocean. Squid, sardine, striped mullet and mackerel were used as bait during the surveys. Results showed that the incidental catch of seabirds were lower for both blue-dyed squid and fish baits than that for non-dyed baits. A marked difference was recorded in the catch rate of seabirds by the Fukuseki-maru No.33, and no birds was taken by the Matsuei-maru No.3 and Fukuryu-maru No.21 when blue-dyed baits were used. Both blue-dyed squid and fish baits were effective in reducing the incidental catch of seabirds as compared with both non-dyed squid and fish baits.

Introduction

Incidental catch of seabirds by the tuna longline fishery often occurs during line setting. It is possible to achieve a significant reduction of incidental catch of seabirds by appropriate mitigation measures taken while setting the line. An experiment using blue-dyed bait was conducted in the Hawaiian swordfish fishery and the effectiveness for the reduction of incidental catch of seabirds was reported (Baird 2001, Boggs 2001). In the Japanese longline survey off South Africa in the Southern Ocean from 2001 to 2003, it was suggested that the blue-dyed bait was effective in reducing the incidental catch of seabirds and not influence on catch rates of tunas compared to non-dyed bait (Minami and Kiyota 2001; 2004). However, it is reported that the effect of the blue-dyed bait may be changed by bait types and the effect of dyed fish on reducing seabird bycatch was weaker than that of dyed squids (Cocking et al. 2008). In this study, the effects of blue-dyed squid and fish baits on incidental catch of seabirds and on catchability of target fishes were examined again by the Japanese longline fishery survey cruises off South Africa in the Southern Ocean from 2001 to 2003.

Materials and methods

Experiment design

The effectiveness of the blue-dyed bait on bycatch mitigation was evaluated by Japanese longline fishery survey cruises targeting southern bluefin tuna. The surveys were conducted by Matsuei-maru No.3 from 5 November 2001 to 14 January 2002, Fukuseki-maru No.33 from 20 October to 27 December 2002 and Fukuryu-maru No.21 from 20 October 2003 to 7 January 2004 off South Africa. The survey was conducted in 62 operations for Matsuei-maru No.3, 61 operations for Fukuseki-maru No.33 and 51 operations for Fukuryu-maru No.21. In each operation, 900 hooks from a total of 1,500 or 2,000 hooks were used for the experiment applying blue-dyed and non-dyed baits. In this 900 hooks, non-dyed baits were used in the first and last sections of 300 hooks respectively, and blue-dyed baits were used in the middle section of 300 hooks. In each operations, tori-line (same as WCPFC standard streamer design) was deployed or not deployed by turns.

Squid and fish (sardine, striped mullet and mackerel) bait were used for the longline bait during the surveys. Baits for blue-dyed bait were previously thawed, dyed with brilliant blue FCF and then re-frozen.

Data analysis

For the analysis of seabird bycatch, only data without tori-line was used because combined use of tori-line and blue-dyed bait was too effective reducing seabird bycatch (zero catch) to detect the effect of blue-dyed bait on bycatch mitigation statistically. For the analysis about southern bluefin tuna catch, all data was used.

The effects of bait type and color on the seabird bycatch and catch of target fishes were calculated by generalized linear model analysis (*glm,* in *STAT* package on the R language software 2.13.1). The number of seabird bycatch (Albatrosses and Petrels) and southern bluefin tuna catch was set as a response variable in each. Bait type (squid or fish), bait color (normal or blue-dyed) and these interaction were set as independent variables. Hook number in each experimental block was set as a offset. Because the frequency is countable data, we assumed that the number of bycatch is Poisson distributed and its link function was set as log-transformed.

Results

Effect of a blue-dyed bait on bycatch mitigation

Bycatch CPUE of albatrosses was decreased by use of each blue-dyed squid and fish bait compared with each non-dyed squid and fish bait in 2001, 2002 and 2003 experiments (Fig. 1-3). Bycatch CPUE of petrels was decreased by use of blue-dyed squid bait compared with each non-dyed squid bait in 2001 and 2003 experiments and reduced by use of blue-dyed fish bait compared with non-dyed fish bait in 2002 and 2003 experiments (Fig. 1-3). Bycatch numbers of albatrosses and petrels were completely eliminated with using combination of tori-line and blue-dyed bait (both squids and fishes). With the all data except tori-line operations, it was clarified by the GLM analyses that bait type did not affect bycatch numbers of albatrosses and petrels but the blue-dyed bait significantly reduced (Table 1, 2). Furthermore, the effect of blue-dying on the bycatch reductions were not related to bait types (Table 1, 2).

Effect of blue-dyed bait on catch of target fishes

Southern bluefin tuna CPUE was decreased by use of blue-dyed bait in each 2001, 2002 and 2003 except for fish bait in the 2003 experiment. With the all data pooled, it was clarified by the GLM analyses that use of squid bait and blue dyed bait decreased catch number of southern bluefin tunas (Table 3). However, the effect of blue-dying on catch number of southern bluefin tuna was not differed among bait types (Table 3).

Discussion

This study indicates that use of blue-dyed baits significantly reduce the incidental catch of albatrosses and petrels irrespective of bait type. This result indicates that even blue-dyed fish bait which was previously reported to be less effective for bycatch mitigation has equivalent effectiveness as blue-dyed squid bait. Thus, blue-dyed bait can be considered as a possible option for reducing incidental catch of seabirds. This result conflicts with the previous experiment (Cocking et al. 2008). The previous study mainly targeted on a seabird species (wedge-tailed shearwater, *Puffinus pacificus*) that is unlikely bycaught in actual tuna longline operation in Southern Pacific (Inoue et al. 2011). So it is possible that cognitive ability of albatross species that are more closely related tuna longline operations would be different from that in the previous result.

This study also clarifies that that the blue-dyed bait was more effective to reduce seabird bycatch when tori-line is deployed simultaneously. Actual mechanism how the combination is effective is left unclear but this result may mean that tori-lines could defend sinking blue-dyed bait from seabirds' attacking by the depth in which they could not detect the bait from sea surface. To quantify the effectiveness of combination use of tori-line and blue-dyed bait, it is needed to examine the seabird ability detecting blue-dyed bait at various water depth (especially shallower than 10 m; Melvin et al. 2010).

While use of blue-dyed bait reduced seabird bycatch, it also reduced catch of target fishes. The reasons may be that blue-color reduces detectiveness also for southern bluefin tuna and that the process of re-freezing in dyed bait makes it less attractive for target fishes. Opposite result was previously reported that the catch rates of tunas and tuna like species for blue-dyed and non-dyed baits were not significantly different in the western Pacific and the eastern tropical Pacific (Minami and Kiyota 2001) but the reason of the difference is left unclear. To apply blue-dyed bait as more reasonable choice for fishermen, it is necessary to improve attractiveness of blue-dyed bait for target fishes.

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Table 1 The effect of blue-dyed bait on number of albatross bycatch with generalized liner model

	Coefficient	Std. Error	P
Intercept	-4.15	0.06	<0.001
Bait type(Fishes=0, squids=1)	-14.15	72.80	0.846
Blue-dyed bait (dyed=0, normal=1)	2.86	0.07	<0.001
Bait type * Blue-dyed bait	12.98	72.80	0.859

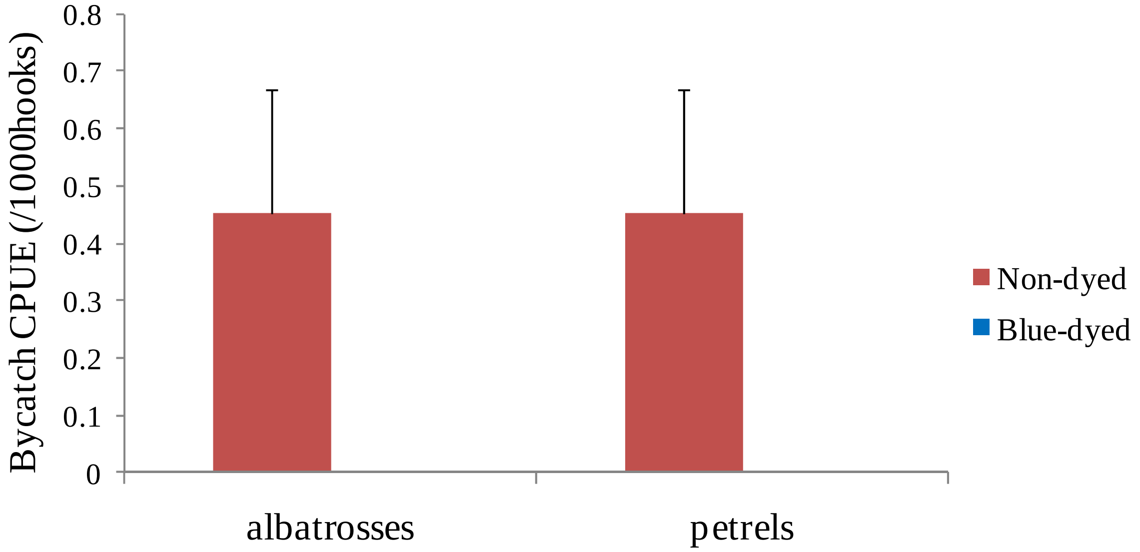
Table 2 The effect of blue-dyed bait on number of petrel bycatch with generalized liner model

	Coefficient	Std. Error	P
Intercept	-4.15	0.06	<0.001
Bait type(Fishes=0, squids=1)	-14.15	72.80	0.846
Blue-dyed bait (dyed=0, normal=1)	2.72	0.07	<0.001
Bait type * Blue-dyed bait	13.16	72.80	0.857

Table 3 The effect of blue-dyed bait on number of southern bluefin tuna catch with generalized liner model

	Coefficient	Std. Error	P
Intercept	-0.04	0.005	<0.001
Bait type(Fishes=0, squids=1)	-0.80	0.015	<0.001
Blue-dyed bait (dyed=0, normal=1)	1.07	0.006	<0.001
Bait type * Blue-dyed bait	-0.02	0.016	0.221

a) Bycatch CPUE in the experiment of Matsuei-maru No. 3, 2001 – squid bait



b) Bycatch CPUE in the experiment of Matsuei-maru No. 3, 2001 – fish bait

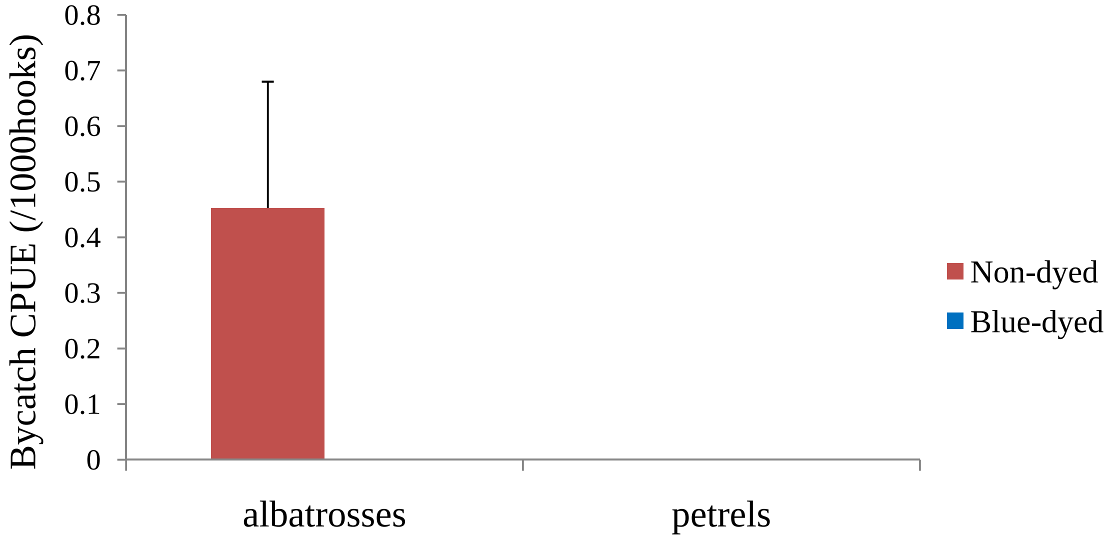
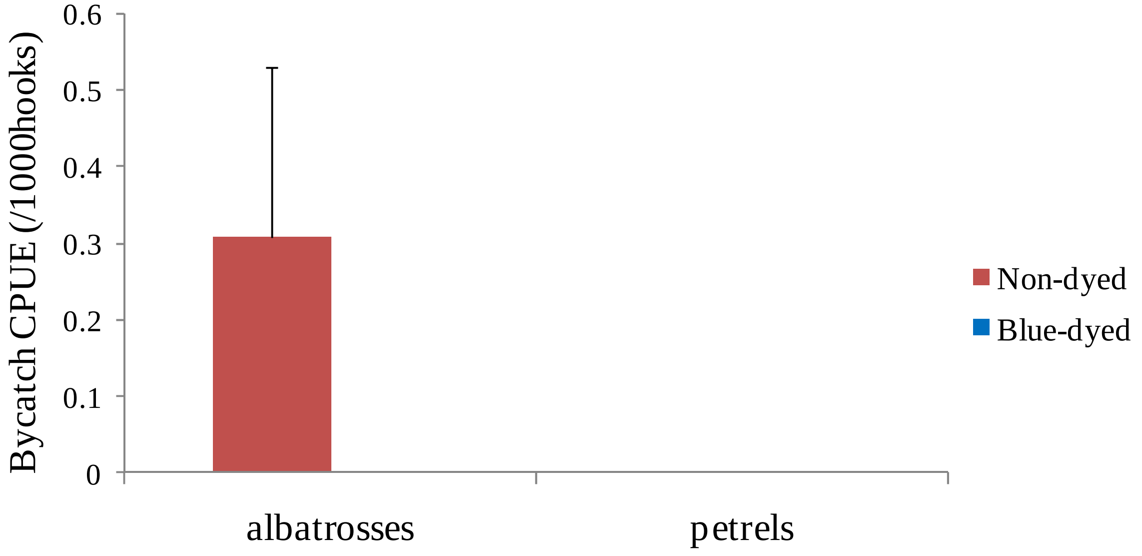


Figure 1. Catch rates (number of catch/1,000 hooks) of seabirds using blue-dyed squid (above) and fish (below) baits in Southern Bluefin Tuna longline fisheries off South Africa in 2001. Error bars indicate standard errors.

a) Bycatch CPUE in the experiment of Fukuseki-maru No. 33, 2002 – squid bait



b) Bycatch CPUE in the experiment of Fukuseki-maru No. 33, 2002 – fish bait

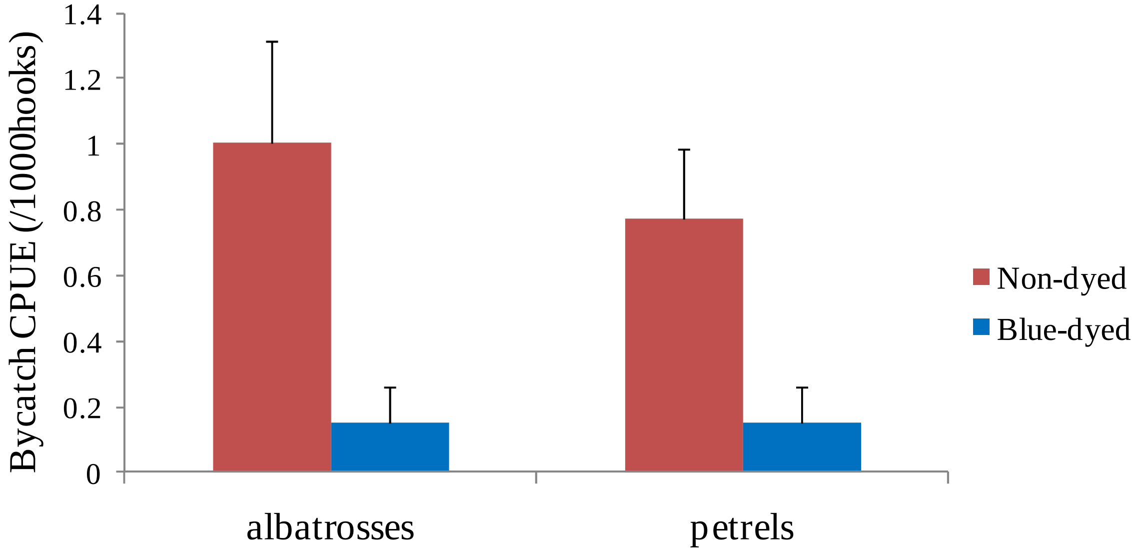
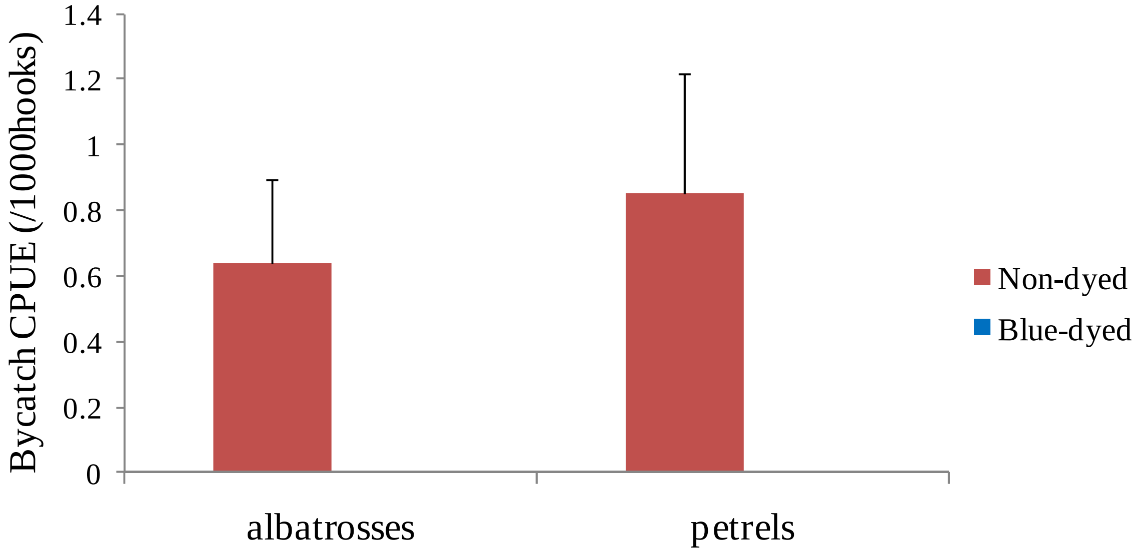


Figure 2. Catch rates (number of catch/1,000 hooks) of seabirds using blue-dyed squid (above) and fish (below) baits in Southern Bluefin Tuna longline fisheries off South Africa in 2002. Error bars indicate standard errors.

a) Bycatch CPUE in the experiment of Fukuryu-maru No. 21, 2003 – squid bait



b) Bycatch CPUE in the experiment of Fukuryu-maru No. 21, 2003 – fish bait

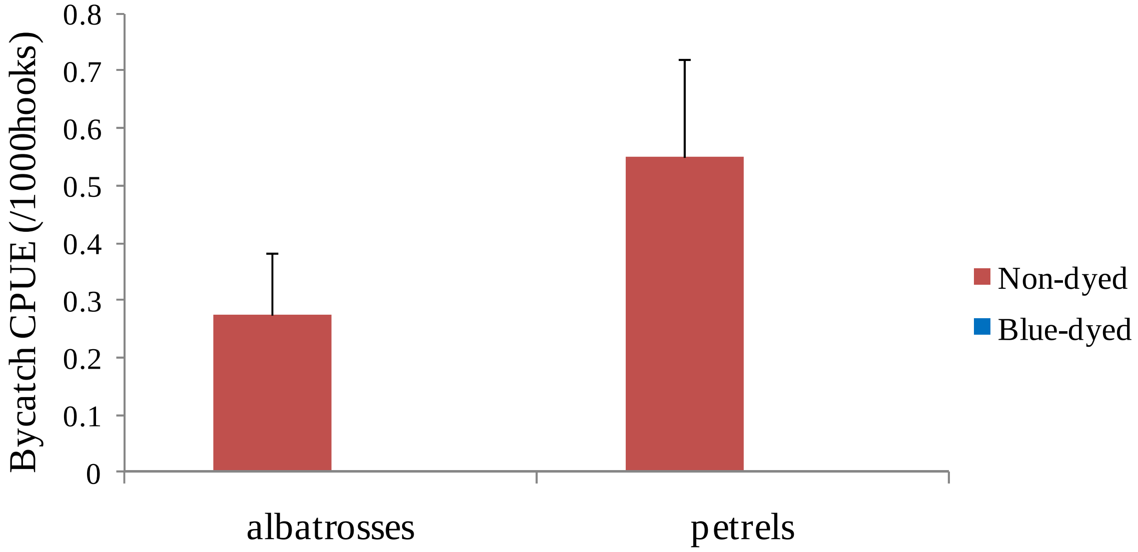
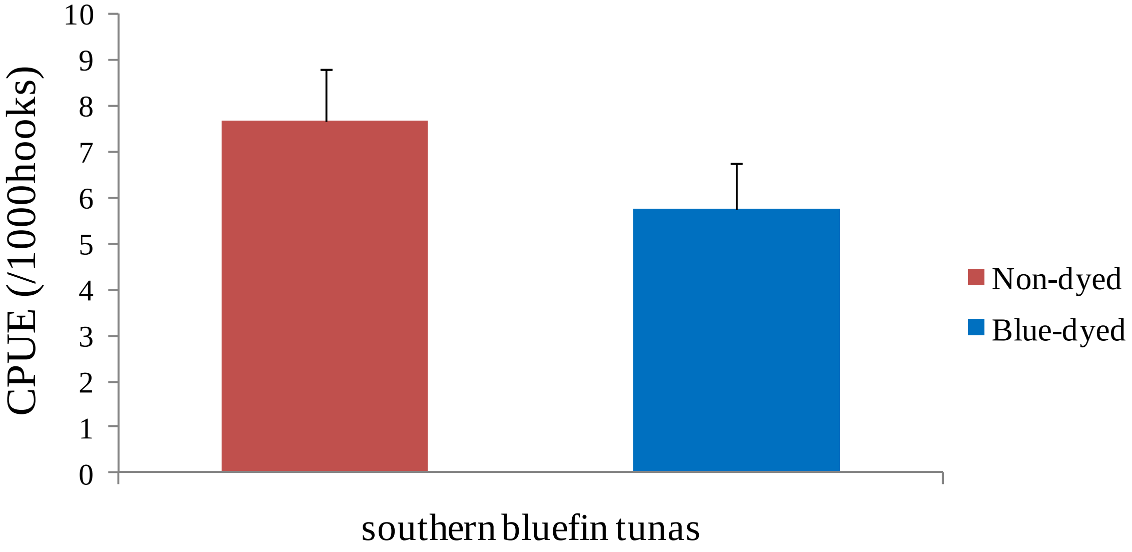


Figure 3. Catch rates (number of catch/1,000 hooks) of seabirds using blue-dyed squid (above) and fish (below) baits in Southern Bluefin Tuna longline fisheries off South Africa in 2003. Error bars indicate standard errors.

a) CPUE of southern bluefin tuna in the experiment of Matsuei-maru No. 3, 2001 – squid bait



b) CPUE of southern bluefin tuna in the experiment of Matsuei-maru No. 3, 2001 – fish bait

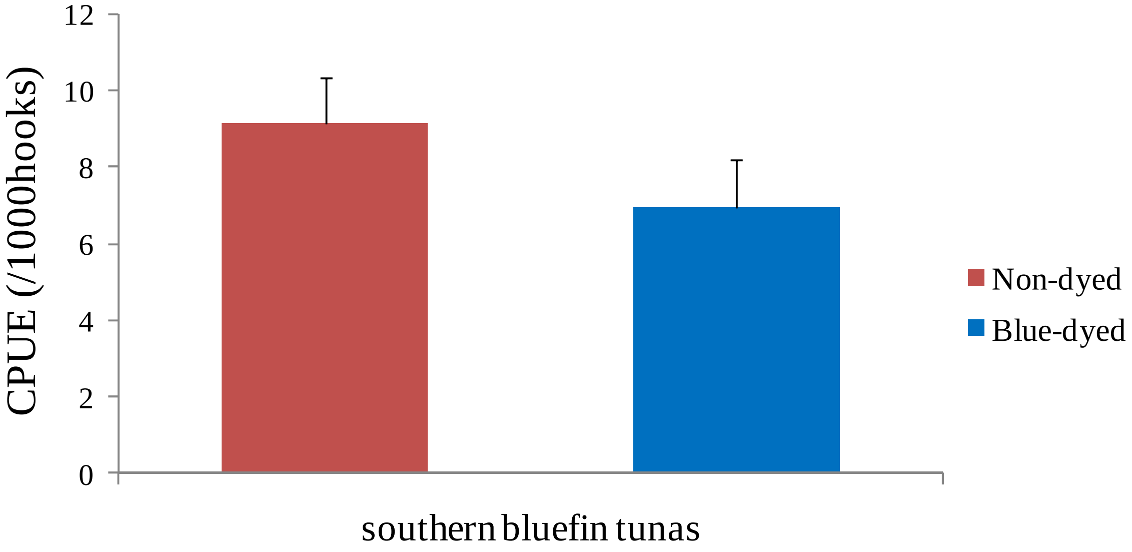
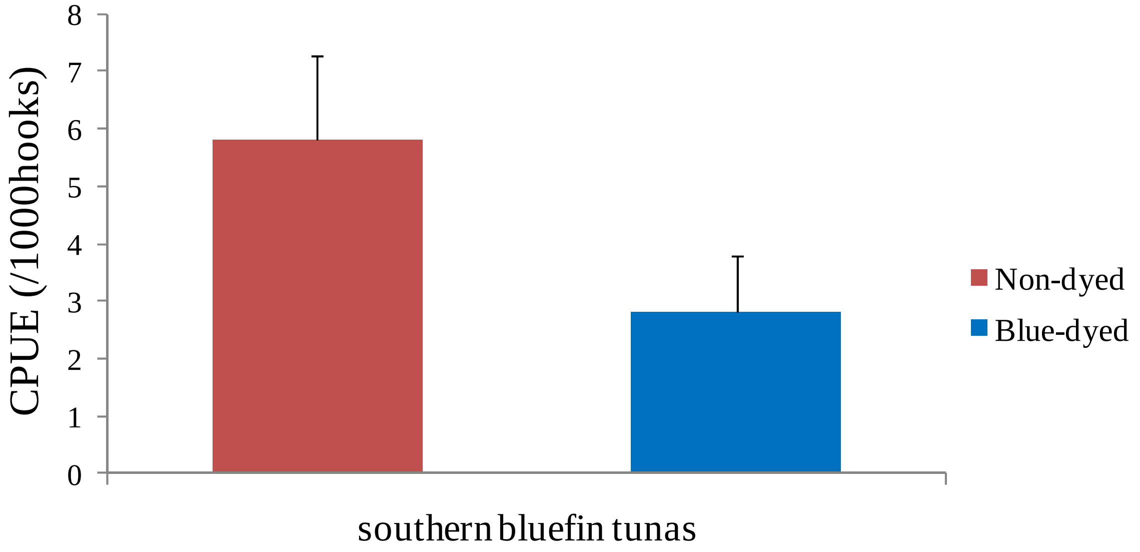


Figure 4. Catch rates (number of catch/1,000 hooks) of southern bluefin tuna using blue-dyed squid (above) and fish (below) baits in Southern Bluefin Tuna longline fisheries off South Africa in 2001. Error bars indicate standard errors.

a) CPUE of southern bluefin tuna in the experiment of Fukuseki-maru No. 33, 2002 – squid bait



b) CPUE of southern bluefin tuna in the experiment of Fukuseki-maru No. 33, 2002 – fish bait

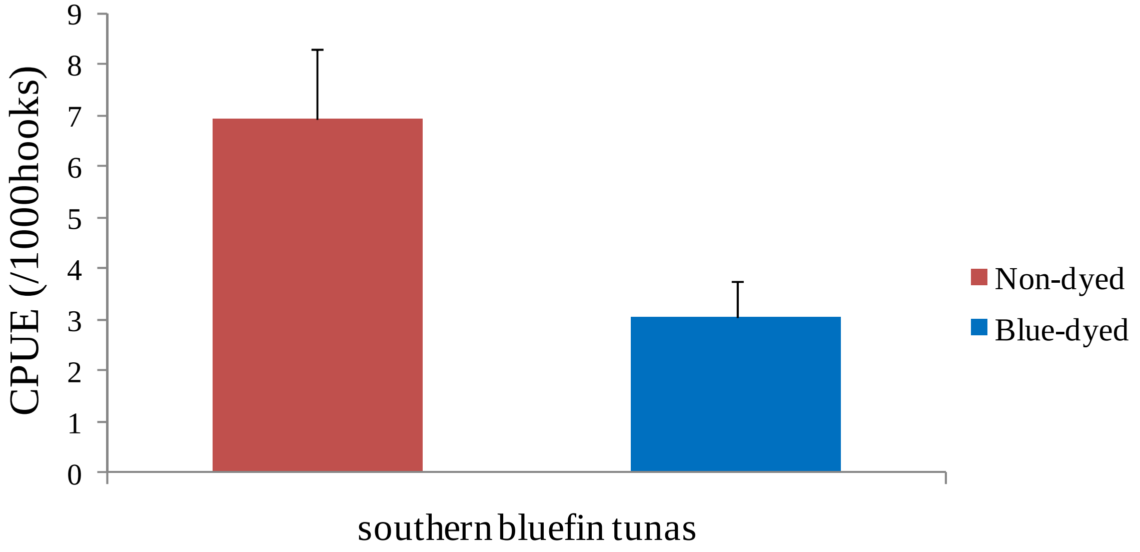
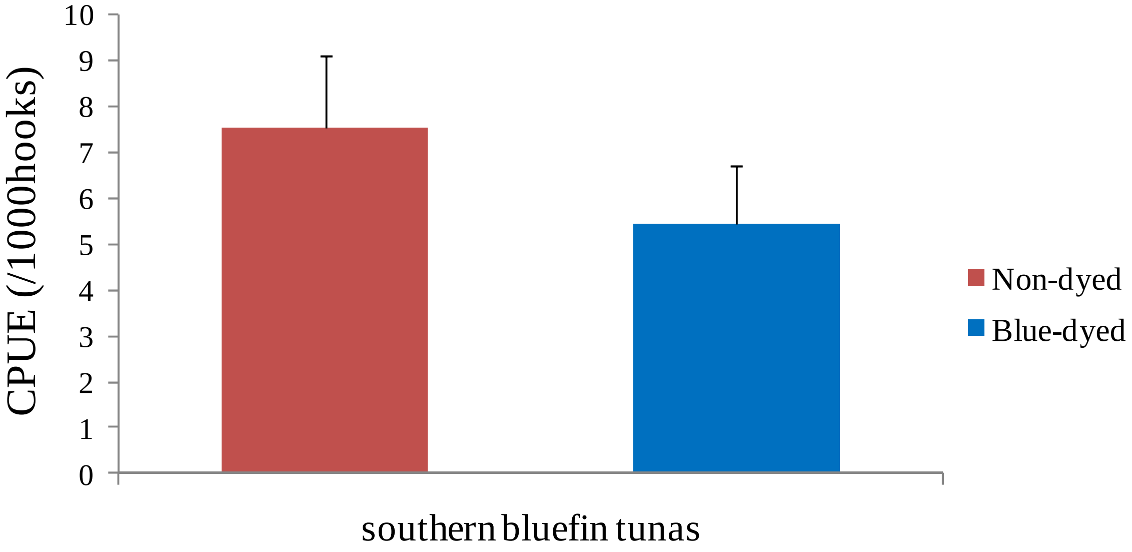


Figure 5. Catch rates (number of catch/1,000 hooks) of southern bluefin tuna using blue-dyed squid (above) and fish (below) baits in Southern Bluefin Tuna longline fisheries off South Africa in 2002. Error bars indicate standard errors.

a) CPUE of southern bluefin tuna in the experiment of Fukuryu-maru No. 21, 2003 – squid bait



b) CPUE of southern bluefin tuna in the experiment of Fukuryu-maru No. 21, 2003 – fish bait

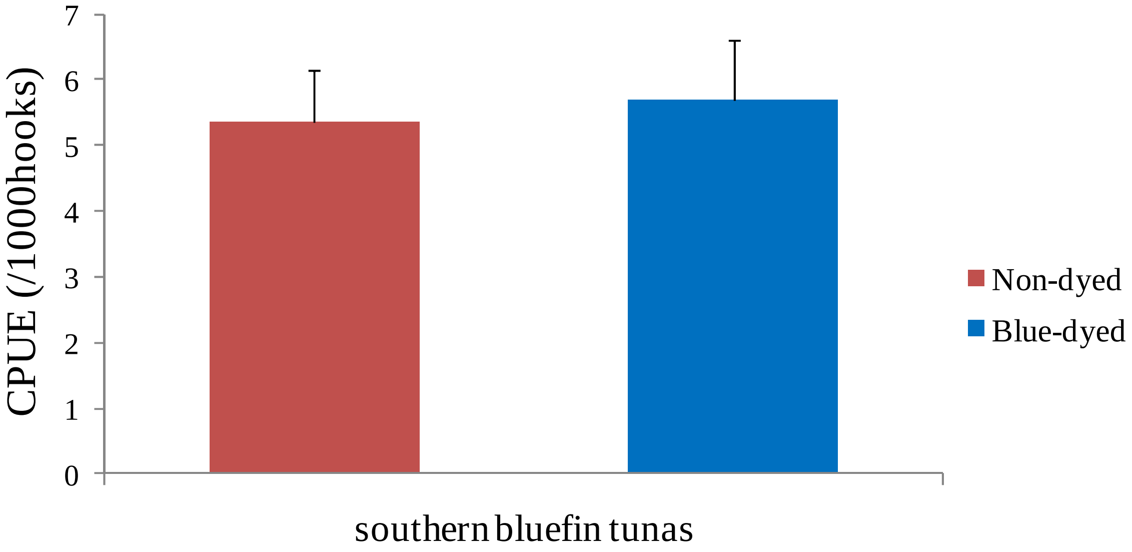


Figure 6. Catch rates (number of catch/1,000 hooks) of southern bluefin tuna using blue-dyed squid (above) and fish (below) baits in Southern Bluefin Tuna longline fisheries off South Africa in 2003. Error bars indicate standard errors.