A Comparison of Highly Migratory Species' Catch Rates from Electronic Monitoring to Logbook and Observer Data in the U.S. South Atlantic and Gulf of Mexico Pelagic Longline Fleet

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List of Acronyms

ALB	Albacore Tuna
ATCA	Atlantic Tunas Convention Act
BET	Bigeye Tuna
BFT	Bluefin Tuna
DOL	Dolphin
EM	Electronic Monitoring
ESC	Escolar
FLS	Fisheries Logbook System
GAM	Generalized Additive Model
HMS	Highly Migratory Species
ICCAT	International Convention of the Conservation of Atlantic Tunas
PLL	Pelagic Longline
POP	Pelagic Observer Program
SEFSC	Southeast Fisheries Science Center
SKJ	Skipjack Tuna
SWO	Swordfish
UDP	Unified Data Processing
VMS	Vessel Monitoring System
WAH	Wahoo
YFT	Yellowfin Tuna

Introduction

Highly Migratory Species (HMS) are species that travel long distances, often traversing across domestic and international boundaries (NOAA Fisheries$_1$, 2019). Atlantic HMS pelagic species include tunas, swordfish and sharks, such as North Atlantic Swordfish *Xiphias gladius,* Western Atlantic Bluefin Tuna *Thunnus Thynus* and Shortfin Mako, *Isurus oxyrinchus*.

These species are managed through a Consolidated Atlantic HMS Fishery Management Plan under the authority of the Magnuson-Stevens Act and the Atlantic Tunas Convention Act (ATCA). NOAA Fisheries manages and regulates HMS species in accordance with International Convention of the Conservation of Atlantic Tuna (ICCAT) recommendations. NOAA Fisheries develops and implements regulations and monitors commercial catches through various sources to ensure compliance with domestic and international quotas and catch limits.

Electronic monitoring (EM) is a tool used to collect fishing data including number of fish caught, fishing effort, and bycatch. Vessels are outfitted with cameras that are triggered by the hydraulic system used to deploy and retrieve gear. Footage of haulback and catch removal or release are sent to a NMFS-contractor within 48 hours of the trip for processing. Between approximately four and fifteen percent of pelagic longline sets are audited and vessel operators are informed that video footage will be compared to logbook and vessel monitoring system (VMS) data (NOAA Fisheries$_2$, 2019).

EM is useful for monitoring compliance with catch limit requirements and involvement with protected resources. The use of technological advancements, including cameras, will aid in supplementing fishery observers and at-sea monitoring, potentially leading to cost savings in the future.

Electronic monitoring programs have been implemented in five U.S. fisheries, including the Bluefin Tuna fishery in 2015. Under Amendment 7 to the Atlantic HMS Fishery Management Plan, fishing vessels with an Atlantic Tunas Longline permit with pelagic longline (PLL) gear are required to have a NMFS-approved system installed to track the catch of and interaction with Bluefin tuna using onboard cameras (NOAA Fisheries, 2014). The HMS pelagic longline fishery was recently added in 2017 and efforts are ongoing to implement EM programs in South Atlantic and Gulf of Mexico commercial fisheries.

Electronic monitoring aims to improve the quality and timeliness of HMS data collected, resulting in enhanced management of these species. The many benefits of increasing fleet coverage include scalability and reduced susceptibility to bias and observer effect (i.e., when fishing activity differs on observed trips versus unobserved trips).

Past studies have compared electronic monitoring footage with observer data, but few have compared footage to logbook data in the pelagic longline fishery (Emery et al. 2019, Gilman et al. 2018, Baum and Blachard, 2010). The primary objective of this study is to compare electronic monitoring data (referred to as video) to the mandatory, self-reported PLL logbook data to quantify the differences between the two data sources.

At-sea fishery observer data is considered to be the most reliable source of fishery-dependent catch and effort data, however, observers only cover approximately 8% of the pelagic longline fleet. An additional goal of this study is to compare all three data collection mechanisms (video, logbook, and observer). Triangulation of these datasets will provide insight into the feasibility of monitoring a larger percentage of the pelagic longline fishery without increasing observer coverage, while continuing to collect the most accurate data.

Methods

Select electronic monitoring footage from the HMS pelagic longline fishery in the Southeast and Gulf of Mexico was collected and audited by NOAA contractors and combined into a dataset cataloging catch of individual species kept and discarded from 2015 to 2019. The initial dataset contains 16 audit periods, each containing select pelagic longline sets from a 3-month period, with the exception of one* (Table 1).

Audit Period	Time Period Covered
1	Jun – Aug 2015
2	Sep – Nov 2015
3	Dec 2015 – Feb 2016
4	Mar – May 2016
5	Jun – Aug 2016
6	Sep – Nov 2016
7	Dec – 2016*
8	Jan – Mar 2017
9	Apr – Jun 2017
10	Jul – Sep 2017
11	Oct – Dec 2017
12	Jan – Mar 2018
13	Apr – Jun 2018
14	Jul – Sep 2018
15	Oct – Dec 2018
16	Jan – Mar 2019

Table 1. Time periods associated with audit periods.

Variable fields available in the EM dataset included vessel ID, set retrieval date, number of species kept and discarded, and comments regarding the condition of the camera views and notable species. Many notes described poor camera angles, blurry views, missing footage, limited view of processing area or out of view completely. Sets with missing dates or null variable fields were removed to create a more complete dataset.

All logbook data were extracted using Oracle SQL Developer to pull vessel ID, landing date, and haulback date from NOAA Southeast Fisheries Science Center's (SEFSC) Unified Data Processing (UDP) database. These records were linked to the Fisheries Logbook System (FLS) database to obtain species types, number of individuals, disposition status (kept or discarded) and gear type. Once the datasets were matched on haulback and landing dates, species counts from trips with multiple sets on the same date were averaged to avoid duplicate matches and obtain consistent set level counts. After matches were made, all audit periods were combined into one dataset.

At-sea observer data was extracted from the Pelagic Observer Program's (POP) database. The electronic monitoring sets were then matched to trips with an observer on board, as indicated on the logbook report, by vessel ID, haulback date, landing date and time period. Because of the limited availability of uniquely identifying variables, logbook, video, and observer data were aggregated at the trip level to avoid the possibility of mismatched sets. Several EM sets did not successfully match to logbook data due to dissimilar haulback dates or preliminary logbooks not yet quality controlled.

A total of 1,774 records out of 1,806 (98%) audited electronically monitored sets were successfully matched and used in the final analysis. The video and logbook dataset contained 11,508 records (Table 2) with 63,468 individual fish (Table 3). The logbook, video, and observer dataset contained 266 unique trips covering a range of species (Table 4).

Species	Kept	Discarded	Total
ALB	1,020	66	1,086
BET	1,952	1,118	3,070
BFT	236	62	298
DOL	2,176	866	3,042
ESC	66	550	616
SKJ	234	50	284
SWO	774	1,364	2,138
WAH	208	-	208
YFT	766	-	766

Table 2. Number of records by species and disposition. Total = 11,508.

Species	Kept	Discarded	Total
ALB	116	4,237	4,353
BET	10,218	13,886	24,104
BFT	334	63	397
DOL	16,585	3,071	19,656
ESC	57	949	1,006
SKJ	353	42	395
SWO	4,034	5,452	9,486
WAH	244	-	244
YFT	3,827	-	3,827

Table 3. Number of individuals by species and disposition. Total = 63,468.

Species	Kept	Discarded	Total
ALB	26	-	26
BET	34	12	46
BFT	17	4	21
DOL	46	16	62
ESC	-	15	15
SWO	23	51	74
WAH	5	-	5
YFT	17	-	17

Table 4. Number of trips with all three matching data sources by species and disposition. Total = 266.

Data Analysis

Once all datasets were matched, a generalized additive model (GAM) with a negative-binomial response structure was fit by restricted maximum likelihood (R *mgcv* package, Wood 2011) to set level fish counts to test for statistical differences between electronic monitoring catch records and logbook reported catch (video model). A second model of the same type was fit to the subset of data used in the model above with a matching observer record (observer model). This allowed for a comparison between the three data sources and provided a means to validate video and logbook data against observer counts.

Parametric terms in each model consisted of data source, species, disposition, and all associated two-way interactions. Comparison by BIC indicated inclusion of the three-way interaction did not substantially improve model fit. Vessel ID and a unique identifier for each set were included as random effect smooths to account for the non-independence of observations taken on the same vessel and the paired nature of observations from different data sources, respectively.

General linear hypothesis tests of species specific contrasts were performed using the *multcomp* package (Hothorn et al. 2008), with p-values adjusted for multiple comparisons using the single-step method.

Results

Results from the video model indicate evidence of differences in average set level reported catch between video and logbook ($p = 0.011$), and that these differences vary by species ($p << 0.001$). There was no evidence that the likelihood of a fish being recorded under a certain disposition (i.e., kept vs. discarded) was different between the two data sources ($p = 0.35$). Inference on species specific contrasts between video and logbook data indicated no significant differences were present for Albacore, Bluefin, Escolar, Swordfish, or Wahoo (either disposition). In contrast, significant differences were present (in both kept and discarded quantities) for Bigeye (7.5% less kept in video data, $p = 0.046$; 10.2% less discarded, $p = 0.007$), Dolphin (11.5% less kept, 14.5% less discarded, $p << 0.001$), Skipjack (78.4% more kept, 73.2% more discarded, $p << 0.001$), and Yellowfin (45.6% less kept, 47.2% more discarded, $p << 0.001$).

The observer model tells a similar story in terms of differences between data sources, however, these differences are largely driven by the discrepancy between observer counts with counts from both video and logbook sources. Observer counts are significantly higher than both video and logbook counts for all species, including Bluefin (for which discrepancies are relatively low compared to more substantial differences observed for other species including Albacore, Bigeye, Dolphin, Swordfish, and Yellowfin). For Bluefin, the model estimates 397% more are reported kept by observers than in logbook reports, while 428% more are reported discarded ($p << 0.001$). Similarly, observers report 592% more Bigeye kept than are recorded on video, and 641% more discarded ($p << 0.001$). As in the video model, there were no significant differences detected between video and logbook counts of Bluefin ($p = 0.78$ kept, $p = 0.82$ discarded).

Limitations and Future Research

Due to the inconsistent format of the discard disposition throughout the audit periods, discarded alive and dead were combined into a single discarded category. Unfortunately, this eliminates some of the precision of the analysis. Future electronic monitoring audits and research should focus on discarded disposition consistency to allow for more detailed analysis.

Due to the limited amount of uniquely identifying variables for the audited electronic monitoring data, trips with multiple sets had to be averaged to avoid the possibility of duplicate matches. There is currently no common unique identifier linking logbook trips to the corresponding observer record, making it impossible to truly match logbook sets to observer sets. Thus, logbook data had to be aggregated at a higher level to avoid the possibility of mismatched observer data, therefore reducing the resolution of the analysis. Going forward, a more robust method of matching logbook data to observer data is needed to conduct more in depth analyses.

References

Atlantic Highly Migratory Species; 2006 Consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan; Amendment 7. 15 C.F.R. § 902 (2014).

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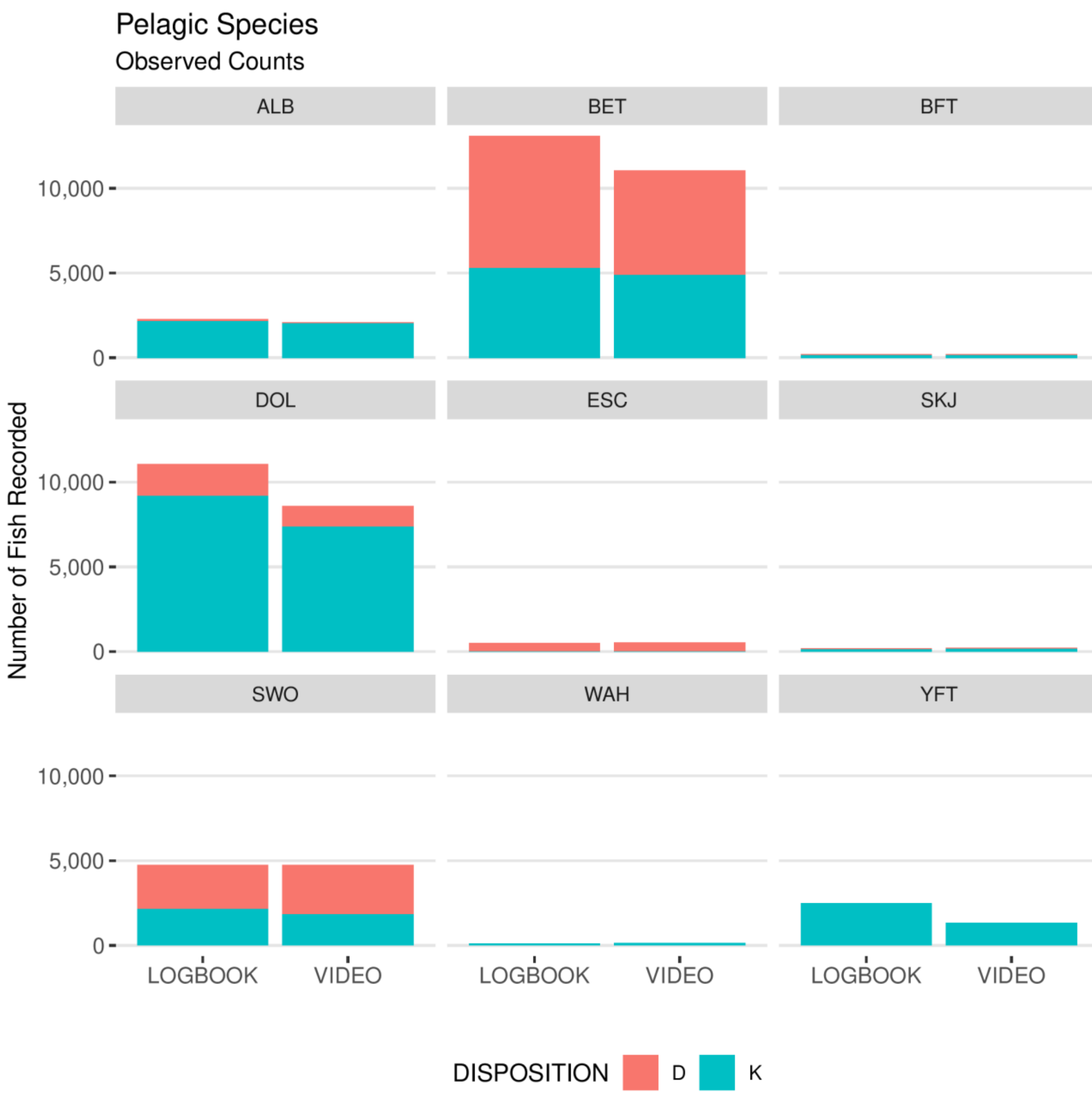
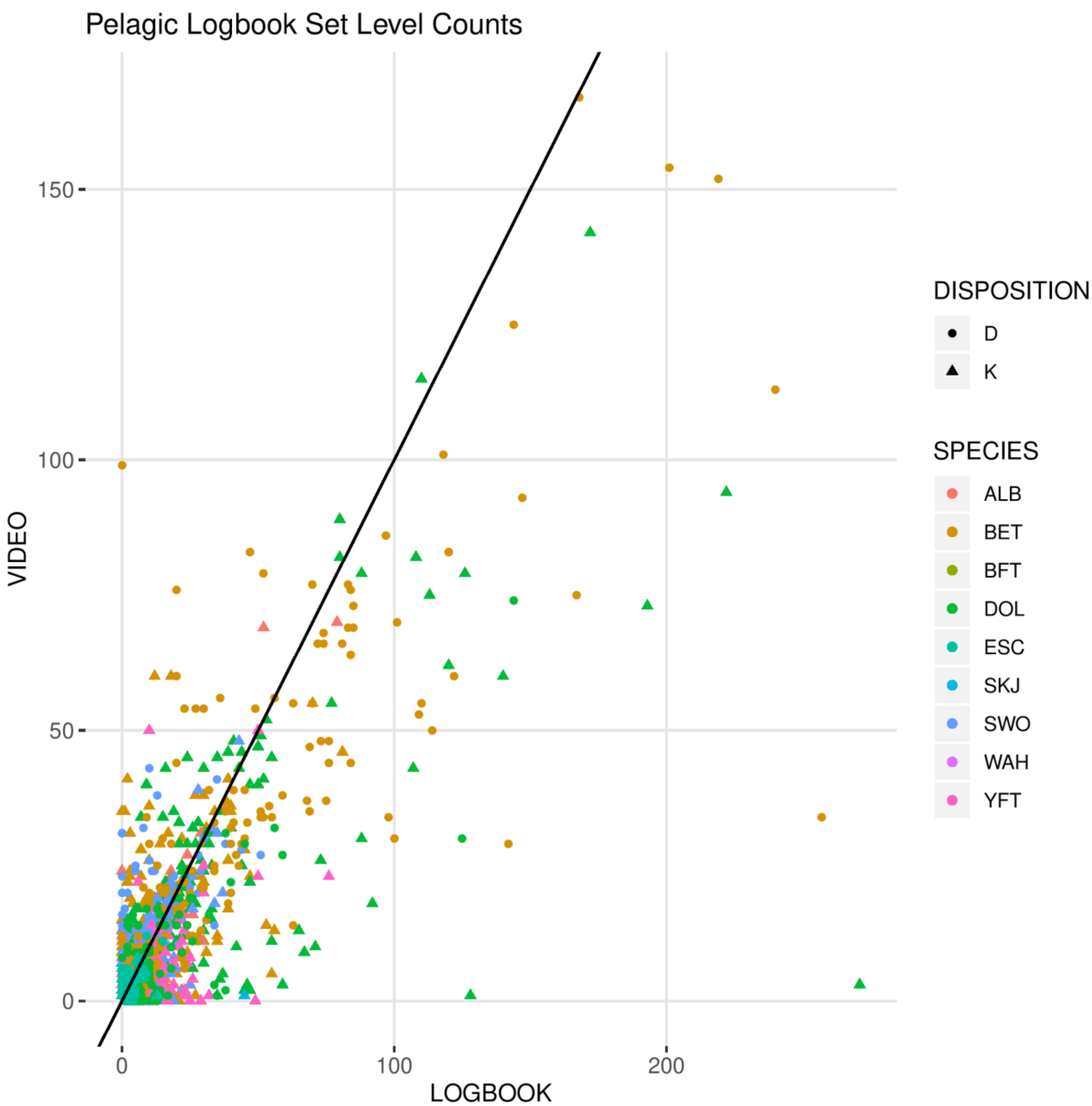
Appendix 1

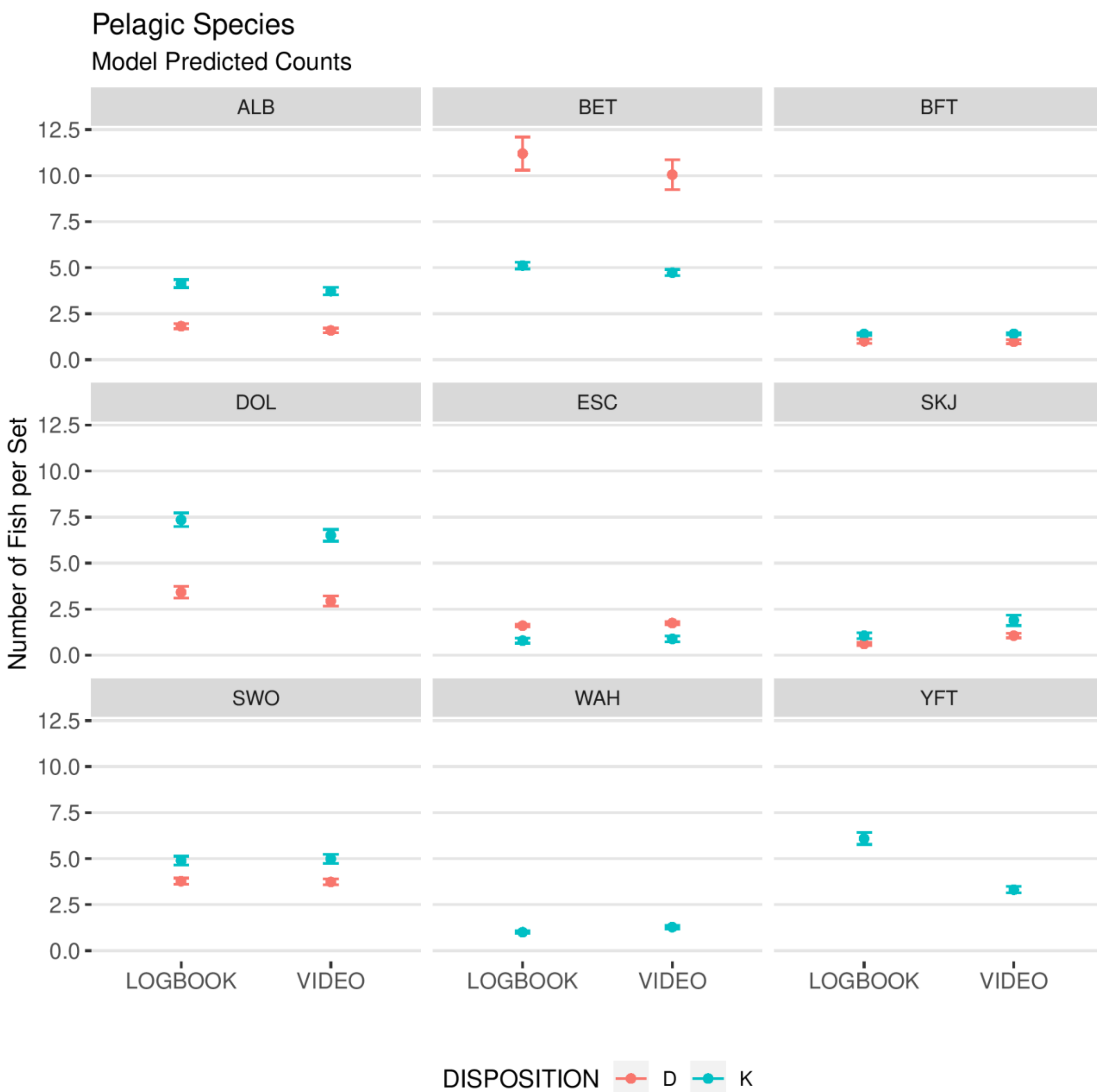
Video/Logbook

Figures and Model Output

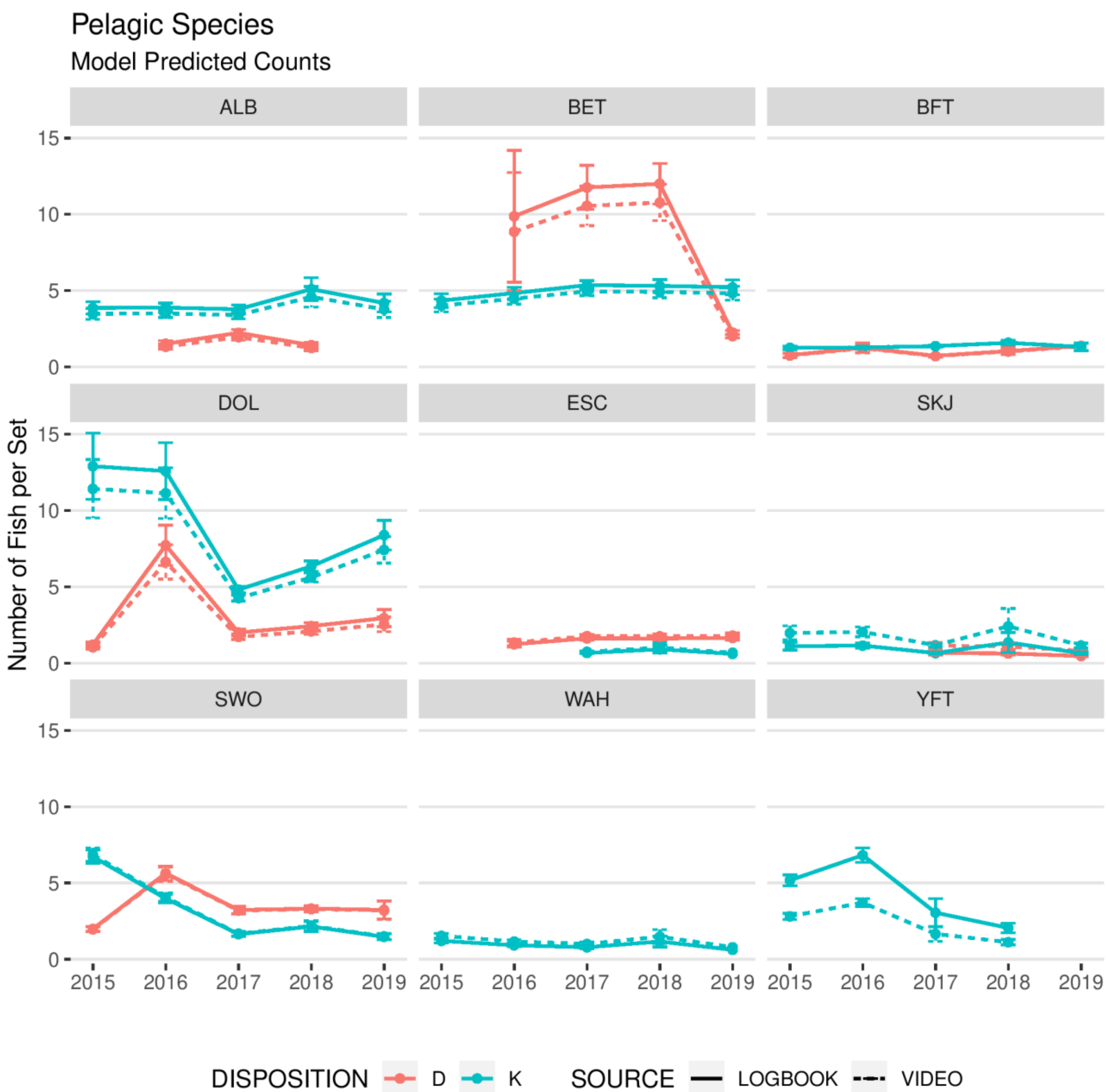


Pelagic Species
Observed Counts
ALB
BET
BFT
DOL
ESC
SKJ
SWO
WAH
YFT
10,000
5,000
0
Number of Fish Recorded
LOGBOOK
VIDEO
DISPOSITION
D
K


Pelagic Logbook Set Level Counts
VIDEO
150
100
50
0
0
100
200
LOGBOOK
DISPOSITION
D
K
SPECIES
ALB
BET
BFT
DOL
ESC
SKJ
SWO
WAH
YFT



Pelagic Species
Model Predicted Counts
ALB
BET
BFT
DOL
ESC
SKJ
SWO
WAH
YFT
Number of Fish per Set
12.5
10.0
7.5
5.0
2.5
0.0
LOGBOOK
VIDEO
DISPOSITION
D
K



Pelagic Species
Model Predicted Counts
ALB
BET
BFT
DOL
ESC
SKJ
SWO
WAH
YFT
Number of Fish per Set
0
5
10
15
2015
2016
2017
2018
2019
DISPOSITION
D
K
SOURCE
LOGBOOK
VIDEO

Negative Binomial GAM (log-link)

	Number of Fish Reported
	Camera vs. Logbook
Constant	0.564*** (0.214)
SOURCEVIDEO	-0.134** (0.053)
SPECIESBET	0.794*** (0.218)
SPECIESBFT	-0.791** (0.319)
SPECIESDOL	0.056 (0.220)
SPECIESESC	-0.239 (0.228)
SPECIESSKJ	-1.207*** (0.348)
SPECIESSWO	0.352 (0.218)
SPECIESWAH	0.000 (0.158)
SPECIESYFT	0.364*** (0.082)
DISPOSITIONK	0.526** (0.218)
SOURCEVIDEO:SPECIESBET	0.026 (0.051)
SOURCEVIDEO:SPECIESBFT	0.110 (0.121)
SOURCEVIDEO:SPECIESDOL	-0.017 (0.050)
SOURCEVIDEO:SPECIESESC	0.218** (0.091)
SOURCEVIDEO:SPECIESSKJ	0.683*** (0.134)
SOURCEVIDEO:SPECIESSWO	0.124** (0.056)
SOURCEVIDEO:SPECIESWAH	0.347** (0.153)
SOURCEVIDEO:SPECIESYFT	-0.504*** (0.066)
SOURCEVIDEO:DISPOSITIONK	0.030 (0.032)
SPECIESBET:DISPOSITIONK	-0.636*** (0.226)
SPECIESBFT:DISPOSITIONK	-0.093 (0.335)
SPECIESDOL:DISPOSITIONK	0.276 (0.227)
SPECIESESC:DISPOSITIONK	-1.414*** (0.326)
SPECIESSKJ:DISPOSITIONK	-0.230 (0.361)
SPECIESSWO:DISPOSITIONK	-0.233 (0.229)
SPECIESWAH:DISPOSITIONK	-1.220*** (0.000)
SPECIESYFT:DISPOSITIONK	0.000 (0.000)
Observations	11,508
Adjusted R2	0.749
Log Likelihood	-26,078
UBRE	28,116
Note:	*p<0.1; **p<0.05; ***p<0.01

Family: Negative Binomial(5.98)
Link function: log

Parametric Terms:

	df	Chi.sq	p-value
SOURCE	1	6.4	0.011
SPECIES	8	235.7	<0.0001
DISPOSITION	1	5.8	0.016
SOURCE:SPECIES	8	154.3	<0.0001
SOURCE:DISPOSITION	1	0.88	0.35
SPECIES:DISPOSITION	6	131.4	<0.0001

Approximate significance of smooth terms:

	edf	Chi.sq	p-value
s(VESID)	59.9	5917	<0.0001
s(ID)	4292.2	28624	<0.0001

Simultaneous Tests for General Linear Hypotheses

Linear Hypotheses:

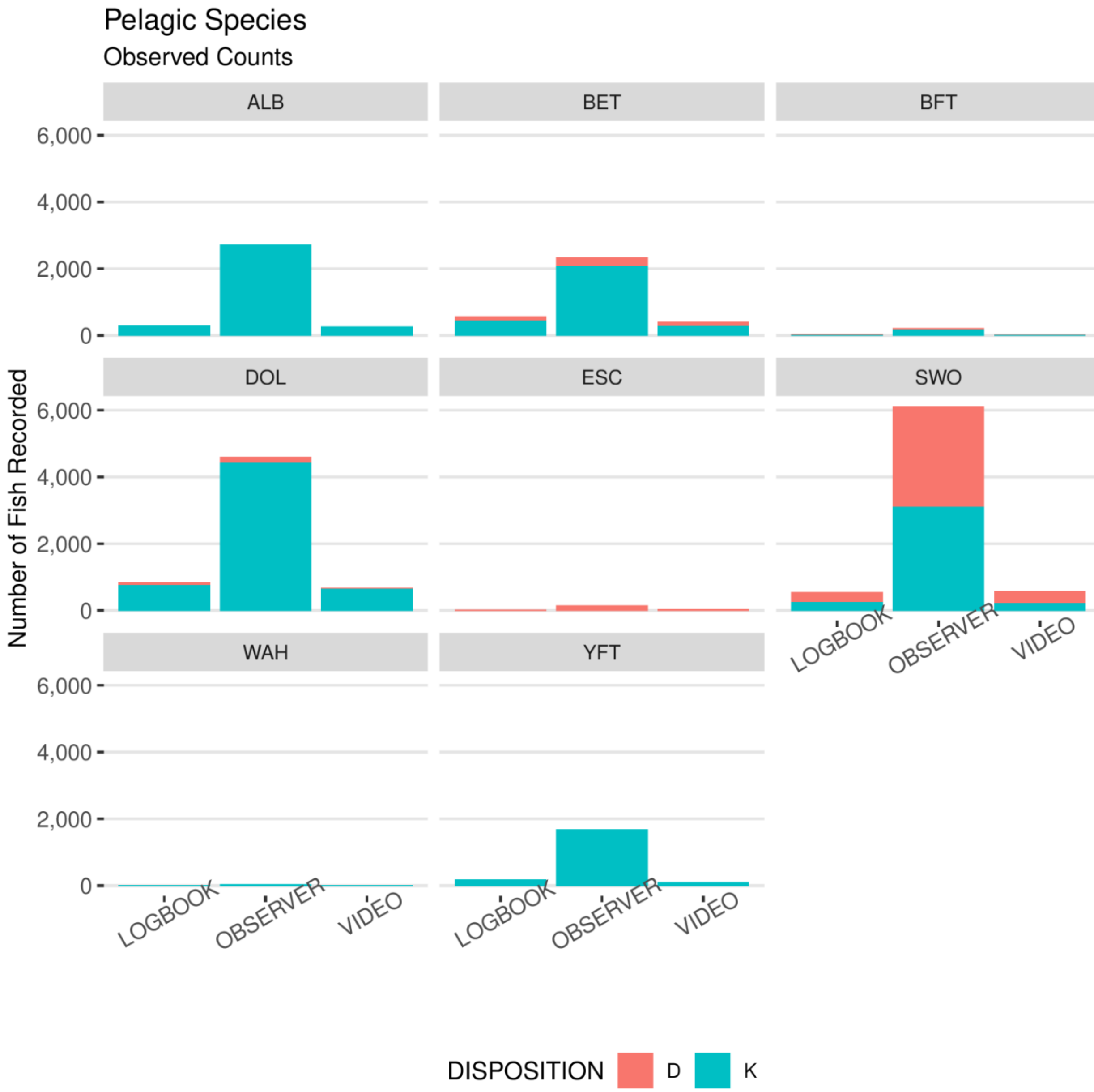
	Estimate	Lower	Upper	p-value	
ALB VIDEO VS LOGBOOK KEPT	-9.9	-20.6	2.2	0.189	
ALB VIDEO VS LOGBOOK DISCARDED	-12.6	-25.1	2.0	0.140	
BET VIDEO VS LOGBOOK KEPT	-7.5	-14.4	-0.1	0.046	*
BET VIDEO VS LOGBOOK DISCARDED	-10.2	-18.0	-1.8	0.007	**
BFT VIDEO VS LOGBOOK KEPT	0.5	-27.7	39.8	1.000	
BFT VIDEO VS LOGBOOK DISCARDED	-2.4	-30.4	36.8	1.000	
DOL VIDEO VS LOGBOOK KEPT	-11.5	-17.8	-4.7	<0.001	***
DOL VIDEO VS LOGBOOK DISCARDED	-14.1	-22.5	-4.8	<0.001	***
ESC VIDEO VS LOGBOOK KEPT	12.0	-11.4	41.6	0.865	
ESC VIDEO VS LOGBOOK DISCARDED	8.7	-12.6	35.2	0.967	
SKJ VIDEO VS LOGBOOK KEPT	78.4	23.5	157.7	<0.001	***
SKJ VIDEO VS LOGBOOK DISCARDED	73.2	18.9	152.2	<0.001	***
SWO VIDEO VS LOGBOOK KEPT	1.9	-8.1	13.1	0.999	
SWO VIDEO VS LOGBOOK DISCARDED	-1.0	-10.1	8.9	1.000	
WAH VIDEO VS LOGBOOK KEPT	27.4	-16.7	95.0	0.705	
WAH VIDEO VS LOGBOOK DISCARDED	23.7	-20.0	91.2	0.857	
YFT VIDEO VS LOGBOOK KEPT	-45.6	-52.9	-37.2	<0.001	***
YFT VIDEO VS LOGBOOK DISCARDED	-47.2	-55.5	-37.3	<0.001	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)

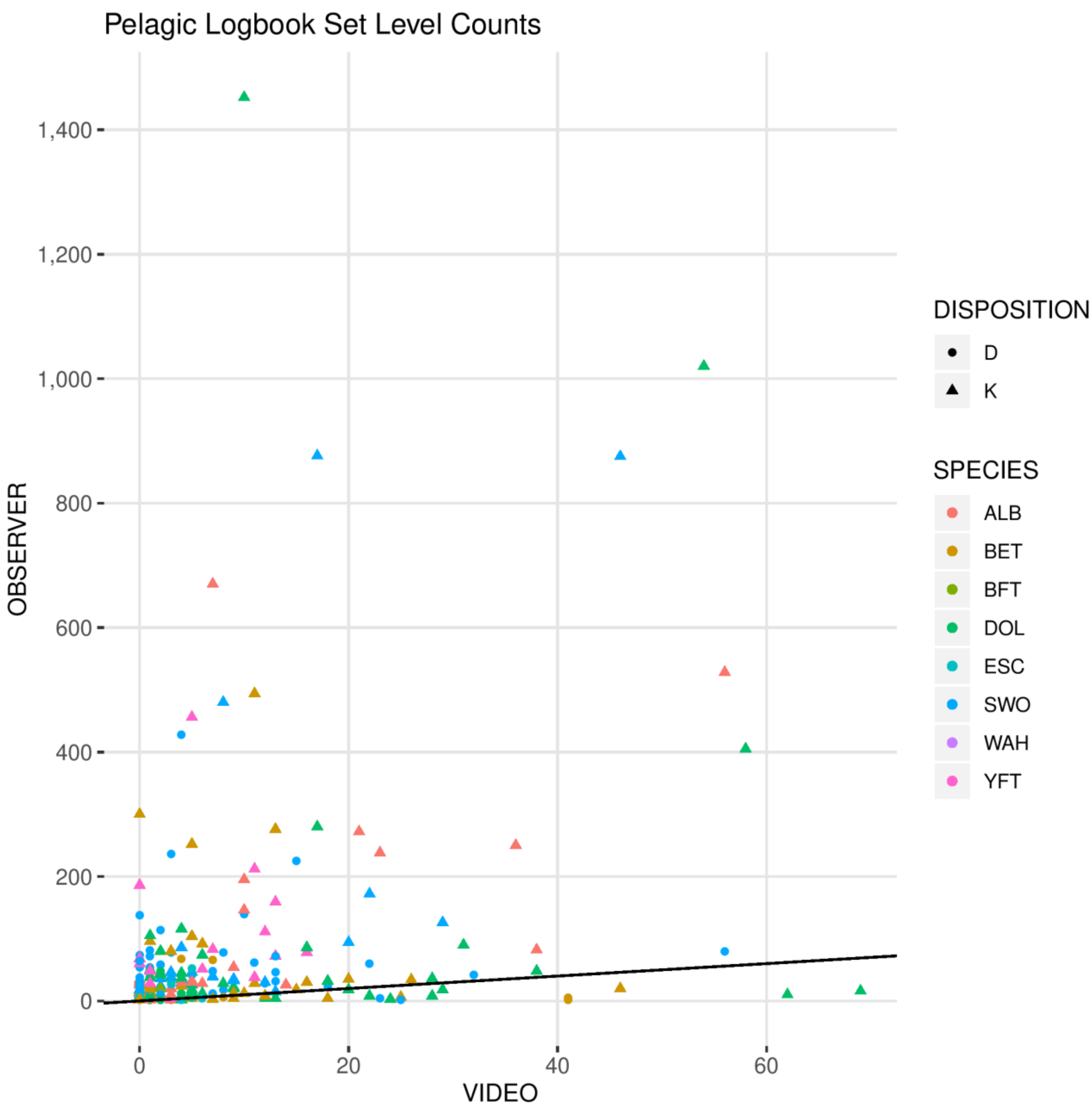
<u>Appendix 2</u>

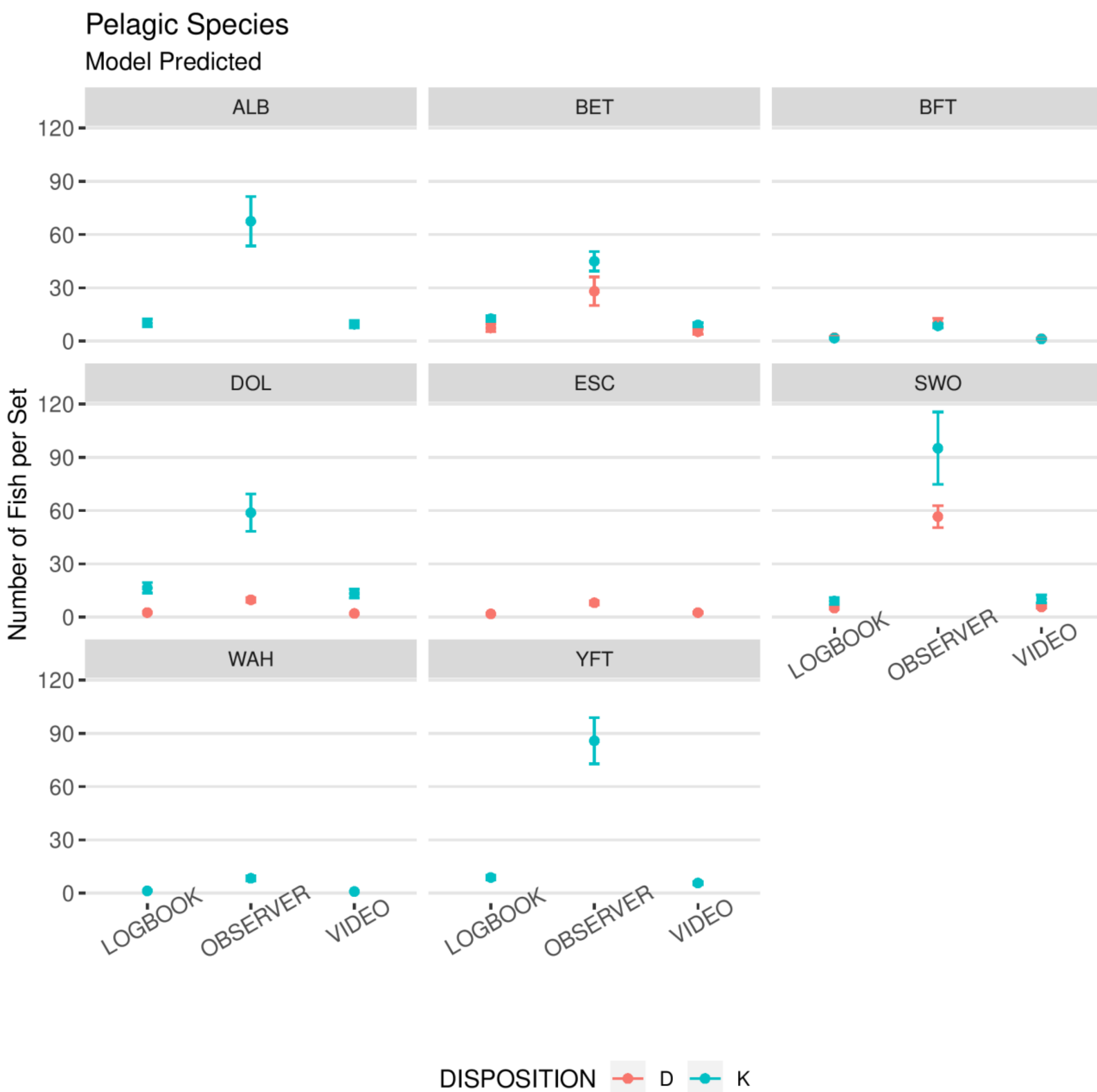
Observer/Video/Logbook

Figures and Model Output



Pelagic Species
Observed Counts
ALB
BET
BFT
DOL
ESC
SWO
WAH
YFT
6,000
4,000
2,000
0
Number of Fish Recorded
LOGBOOK
OBSERVER
VIDEO
DISPOSITION
D
K


Pelagic Logbook Set Level Counts
OBSERVER
VIDEO
1,400
1,200
1,000
800
600
400
200
0
0
20
40
60
DISPOSITION
D
K
SPECIES
ALB
BET
BFT
DOL
ESC
SWO
WAH
YFT


Pelagic Species
Model Predicted
ALB
BET
BFT
DOL
ESC
SWO
WAH
YFT
Number of Fish per Set
0
30
60
90
120
LOGBOOK
OBSERVER
VIDEO
DISPOSITION
D
K

Negative Binomial GAM (log-link)

	Number of Fish Reported
	Obs. vs. Camera vs. Logbook
Constant	0.435 (0.636)
SOURCEOBSERVER	1.947*** (0.321)
SOURCEVIDEO	-0.079 (0.341)
SPECIESBET	1.001 (0.693)
SPECIESBFT	0.262 (0.403)
SPECIESDOL	0.171 (0.676)
SPECIESESC	0.000 (0.731)
SPECIESSWO	0.932 (0.649)
SPECIESWAH	-1.776** (0.702)
SPECIESYFT	0.000 (0.000)
DISPOSITIONK	1.428** (0.588)
SOURCEOBSERVER:SPECIESBET	-0.619** (0.311)
SOURCEVIDEO:SPECIESBET	-0.256 (0.326)
SOURCEOBSERVER:SPECIESBFT	-0.283 (0.404)
SOURCEVIDEO:SPECIESBFT	-0.261 (0.453)
SOURCEOBSERVER:SPECIESDOL	-0.616** (0.297)
SOURCEVIDEO:SPECIESDOL	-0.144 (0.312)
SOURCEOBSERVER:SPECIESESC	-0.461 (0.494)
SOURCEVIDEO:SPECIESESC	0.408 (0.526)
SOURCEOBSERVER:SPECIESSWO	0.463 (0.320)
SOURCEVIDEO:SPECIESSWO	0.195 (0.337)
SOURCEOBSERVER:SPECIESWAH	-0.008 (0.722)
SOURCEVIDEO:SPECIESWAH	-0.276 (0.855)
SOURCEOBSERVER:SPECIESYFT	0.390 (0.389)
SOURCEVIDEO:SPECIESYFT	-0.362 (0.413)
SOURCEOBSERVER:DISPOSITIONK	-0.059 (0.206)
SOURCEVIDEO:DISPOSITIONK	0.009 (0.221)
SPECIESBET:DISPOSITIONK	-0.590 (0.660)
SPECIESBFT:DISPOSITIONK	-1.751*** (0.000)
SPECIESDOL:DISPOSITIONK	0.267 (0.637)
SPECIESESC:DISPOSITIONK	0.000 (0.000)
SPECIESSWO:DISPOSITIONK	-0.984 (0.625)
SPECIESWAH:DISPOSITIONK	0.000 (0.000)
SPECIESYFT:DISPOSITIONK	0.062 (0.383)
Observations	798
Deviance Explained	0.790
Log Likelihood	-2,765
UBRE	2,817
Note:	*p<0.1; **p<0.05; ***p<0.01

Family: Negative Binomial(1.48)

Parametric Terms:

	df	Chi.sq	p-value
SOURCE	2	52.6	<0.0001
SPECIES	6	19.2	0.0039
DISPOSITION	1	5.90	0.015
SOURCE:SPECIES	14	45.1	<0.0001
SOURCE:DISPOSITION	2	0.13	0.94
SPECIES:DISPOSITION	4	12.2	0.016

Approximate significance of smooth terms:

	edf	Chi.sq	p-value
s(VESID)	20.4	226.3	0.0002
s(ID)	156.6	553.9	<0.0001

Simultaneous Tests for General Linear Hypotheses

Linear Hypotheses:

	Estimate	Lower	Upper	p-value
ALB OBSERVER VS LOGBOOK KEPT	560.2	199.1	1357.4	<0.01 ***
ALB OBSERVER VS LOGBOOK DISCARDED	600.7	149.6	1867.2	<0.01 ***
ALB OBSERVER VS VIDEO KEPT	607.8	219.6	1467.4	<0.01 ***
ALB OBSERVER VS VIDEO DISCARDED	658.0	168.0	2043.6	<0.01 ***
ALB VIDEO VS LOGBOOK KEPT	-6.7	-59.5	114.6	1.000
ALB VIDEO VS LOGBOOK DISCARDED	-7.6	-69.0	176.1	1.000
BET OBSERVER VS LOGBOOK KEPT	255.5	93.4	553.4	<0.01 ***
BET OBSERVER VS LOGBOOK DISCARDED	277.3	74.4	716.4	<0.01 ***
BET OBSERVER VS VIDEO KEPT	392.3	165.4	813.2	<0.01 ***
BET OBSERVER VS VIDEO DISCARDED	427.2	140.6	1055.5	<0.01 ***
BET VIDEO VS LOGBOOK KEPT	-27.8	-61.8	36.4	0.935
BET VIDEO VS LOGBOOK DISCARDED	-28.4	-68.5	62.6	0.993
BFT OBSERVER VS LOGBOOK KEPT	397.4	77.7	1292.0	<0.01 ***
BFT OBSERVER VS LOGBOOK DISCARDED	427.9	67.0	1569.3	<0.01 ***
BFT OBSERVER VS VIDEO KEPT	592.3	134.1	1947.6	<0.01 ***
BFT OBSERVER VS VIDEO DISCARDED	641.4	122.6	2369.6	<0.01 ***
BFT VIDEO VS LOGBOOK KEPT	-28.2	-78.2	136.4	1.000
BFT VIDEO VS LOGBOOK DISCARDED	-28.8	-80.8	164.5	1.000
DOL OBSERVER VS LOGBOOK KEPT	256.8	109.2	508.3	<0.01 ***
DOL OBSERVER VS LOGBOOK DISCARDED	278.6	81.9	688.1	<0.01 ***
DOL OBSERVER VS VIDEO KEPT	341.8	157.7	657.5	<0.01 ***
DOL OBSERVER VS VIDEO DISCARDED	373.1	124.7	896.2	<0.01 ***
DOL VIDEO VS LOGBOOK KEPT	-19.2	-53.7	40.9	0.997
DOL VIDEO VS LOGBOOK DISCARDED	-20.0	-63.6	76.0	0.999
ESC OBSERVER VS LOGBOOK KEPT	316.3	5.1	1548.4	0.034 *
ESC OBSERVER VS LOGBOOK DISCARDED	341.8	32.2	1376.1	<0.01 **
ESC OBSERVER VS VIDEO KEPT	196.7	-22.1	1029.8	0.264
ESC OBSERVER VS VIDEO DISCARDED	217.7	- 0.1	910.8	0.050 .
ESC VIDEO VS LOGBOOK KEPT	40.3	-67.8	510.8	1.000
ESC VIDEO VS LOGBOOK DISCARDED	39.1	-61.7	404.4	1.000
SWO OBSERVER VS LOGBOOK KEPT	948.8	445.1	1918.1	<0.01 ***
SWO OBSERVER VS LOGBOOK DISCARDED	1013.1	560.8	1775.0	<0.01 ***
SWO OBSERVER VS VIDEO KEPT	825.6	380.5	1682.9	<0.01 ***
SWO OBSERVER VS VIDEO DISCARDED	891.2	490.1	1565.2	<0.01 ***
SWO VIDEO VS LOGBOOK KEPT	13.3	-43.3	126.5	1.000
SWO VIDEO VS LOGBOOK DISCARDED	12.3	-35.5	95.5	1.000
WAH OBSERVER VS LOGBOOK KEPT	555.3	-26.0	5704.0	0.181
WAH OBSERVER VS LOGBOOK DISCARDED	595.5	-28.8	6696.1	0.197
WAH OBSERVER VS VIDEO KEPT	826.1	-10.1	9444.5	0.078 .
WAH OBSERVER VS VIDEO DISCARDED	891.8	-12.4	11131.3	0.086 .
WAH VIDEO VS LOGBOOK KEPT	-29.2	-94.8	870.2	1.000
WAH VIDEO VS LOGBOOK DISCARDED	-29.9	-95.3	956.6	1.000
YFT OBSERVER VS LOGBOOK KEPT	875.3	271.7	2459.1	<0.01 ***
YFT OBSERVER VS LOGBOOK DISCARDED	935.1	221.2	3235.6	<0.01 ***
YFT OBSERVER VS VIDEO KEPT	1401.7	458.0	3941.4	<0.01 ***
YFT OBSERVER VS VIDEO DISCARDED	1508.2	386.7	5214.4	<0.01 ***
YFT VIDEO VS LOGBOOK KEPT	-35.1	-76.9	82.2	0.991
YFT VIDEO VS LOGBOOK DISCARDED	-35.6	-81.6	125.1	0.999

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)