Annual Report: 2022 Bottomfish Fishery-Independent Survey in Hawai‘i

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Executive Summary

The Bottomfish Fishery-Independent Survey in Hawai'i (BFISH) is designed to provide accurate and precise estimates of species-specific, size-structured abundance and biomass for the main Hawaiian Islands (MHI) Deep 7 bottomfish. BFISH data are specifically designed to complement and enhance Deep 7 stock assessments conducted by the Pacific Islands Fisheries Science Center (PIFSC).

BFISH is conducted annually across the eight islands of the MHI using two complimentary sampling gears: (1) cooperative research hook-and-line fishing; and (2) stereo video camera systems. These gears are randomly deployed according to a stratified random sampling design within specific habitats across depths ranging from 75 to 400 m. In 2022, BFISH sampling was conducted from 31 July to 30 November. Sampling effort was purposely decreased from 750 primary sample units (PSU) in 2021 to 600 in the 2022 BFISH. This was done based on determination of optimal sampling effort required to achieve a specified coefficient of variation (CV, or precision) for species-specific biomass estimates used in MHI Deep 7 stock assessments, with appropriate buffer to account for uncertain vessel availability. Evolution of the survey design from an initial 9-strata survey (based 2011-2015 Maui Nui experiments) to a refined 24-strata survey (based on 2016–2018 BFISH data) and the optimization of sampling effort have greatly improved survey precision.

In 2022, Deep 7 complex biomass was estimated at 4.83 million pounds. Opakapaka, ehu, and onaga, the three principal species for which the survey design was developed, comprised approximately 71% total estimated Deep7 complex biomass of the survey. Opakapaka, ehu, and onaga stock biomasses were estimated at 1.97, 0.85, and 0.61 million pounds, respectively.

The 2022 BFISH survey for the Deep 7 complex achieved a high level of precision. CVs for exploited stock biomasses opakapaka, ehu, and onaga were 20.31%, 14.88%, and 32.02%, respectively. Under the composite experimental design that considered tradeoffs among the three primary species, future total sample allocations of approximately 500 PSU are likely adequate to achieve sufficient precision to support the needs of stock assessment and management decision-making.

Complimentary research is recommended to improve BFISH estimate precision and support Deep 7 stock assessments, including: (i) design analyses focused on reducing sampling effort to achieve optimal target CVs (e.g., through refinement of habitat metrics); (ii) linking survey spatial density estimates to those of the Fishermen's Reporting System (FRS) to improve spatial density estimates useful for BFISH domain stratification, and further, the effective area fished by the bottomfish fleets for FRS CPUE estimation to support stock assessments; and (iii) analysis of wind stress impacts on effective nominal fishing effort and spatial stock abundance. Technical improvements to BFISH estimation includes determination of effective camera sampling area and extending the depth range of cameras to those of cooperative fishers using non-obtrusive artificial lighting.

Overall survey design and logistics have matured to the point that given (1) population genetics to determine stock domains and (2) adequate mapping data for domain stratification, expansion of the BFISH Fishery-Independent Survey methodology into other U.S. Pacific Territorial Regions now appears practicable.

Introduction

Commercial and recreational fishing are important to the economy and culture of Hawaiʻi (Haight et al. 1993). The Hawaiian deep-slope (100−400 m) fishery consists of seven high-value bottomfish species (i.e., six snappers and one grouper), hereafter referred to as Deep 7 (Figure 1), that account for more than 50% of the total insular commercial catch (Western Pacific Regional Fishery Management Council 2010).
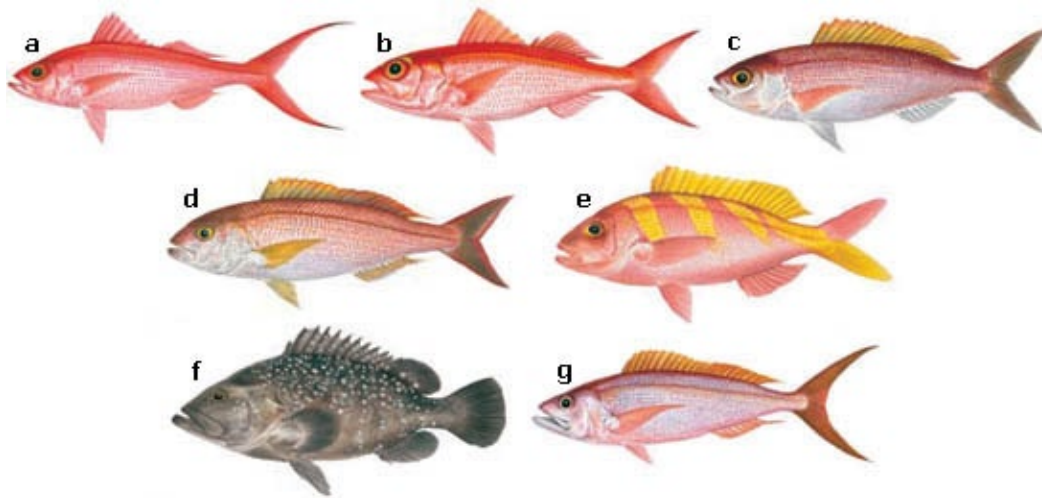
Figure 1. The main Hawaiian Islands "Deep-7" bottomfish complex: (A) Onaga (*Etelis coruscans*), (B) Ehu (*Etelis carbunculus*), (C) Kalekale (*Pristipomoides sieboldii*), (D) Opakapaka (*Pristipomoides filamentosus*), (E) Gindai (*Pristipomoides zonatus*), (F) Hapuʻupuʻu (*Hyporthodus quernus*), and (G) Lehi (*Aphareus rutilans*). Artwork by Les Hata (Hawaiʻi DAR/DLNR).

Under the Magnuson-Stevens Fishery Conservation and Management Act (United States Congress 2007), the National Oceanic and Atmospheric Administration's (NOAA) Pacific Islands Fisheries Science Center (PIFSC) is responsible for conducting stock assessments of the Deep 7 complex. These assessments determine stock status from which the Western Pacific Regional Fishery Management Council (WPRFMC) recommends annual fishery catch limits.

The conventional stock assessment process requires reliable time-series of catches, fishing effort, and life history demographics to estimate stock abundance trends and evaluate sustainability benchmarks (Quinn and Deriso 1999; Haddon 2011). Until recently, stock assessments for the main Hawaiian Islands Deep 7 bottomfish complex (Brodziak et al. 2014) relied on trends in fishery-dependent catch per unit effort (CPUE). However, fishery-dependent CPUE abundance index can be biased due to nonrandom spatiotemporal distribution of fishing effort and gears, imposed length and catch regulations, market forces, and fisher behavior (Hilborn and Walters 1992; Maunder and Punt 2004; Ault et al. 2014).

PIFSC has continually strived to improve data used in the Deep 7 stock assessments. To this end, in 2016, PIFSC implemented a multi-gear Bottomfish Fishery-Independent Survey in Hawaiʻi (BFISH) (Richards et al. 2016). There are several key advantages of fishery-independent surveys: (1) they employ formal experimental designs; (2) they control the distribution of fishing effort and gears; (3) they are less influenced by market forces; and (4) they obtain similar stock

size-structured abundance data as fishery-dependent catch sampling programs, but they do so with greater statistical rigor (Ault et al. 1999; Smith et al. 2011). Fishery-independent surveys can be designed to estimate absolute population abundance, thus providing an important independent estimate of stock abundance for use in stock assessment.

The BFISH survey, a flagship PIFSC effort, was developed from 2011 through 2015 using a series of pilot gear calibration studies in the Maui-Nui island region (Richards et al. 2016) and became operational in 2016. BFISH 2016 data, which included estimates of absolute size-structured abundance and biomass (Ault et al. 2018), were incorporated into the 2018 benchmark Deep 7 bottomfish stock assessment for the MHI (Langseth et al. 2018) as well as its 2021 update (Syslo et al. 2021). In this report, we present results from the 2022 BFISH survey.

Methods

BFISH employs a stratified-random sampling (StRS) design conducted throughout the survey domain (Figure 2), comprising mapped bottomfish habitats at depths of ≥ 75 to 400 m around all eight main Hawaiian Islands (MHI). The survey domain ranges ~600 km from the Big Island of Hawaiʻi to the island of Niʻihau and is divided into 23,613 habitat-classified primary sampling units (PSU) or "grid-cells" of 500 × 500 m.
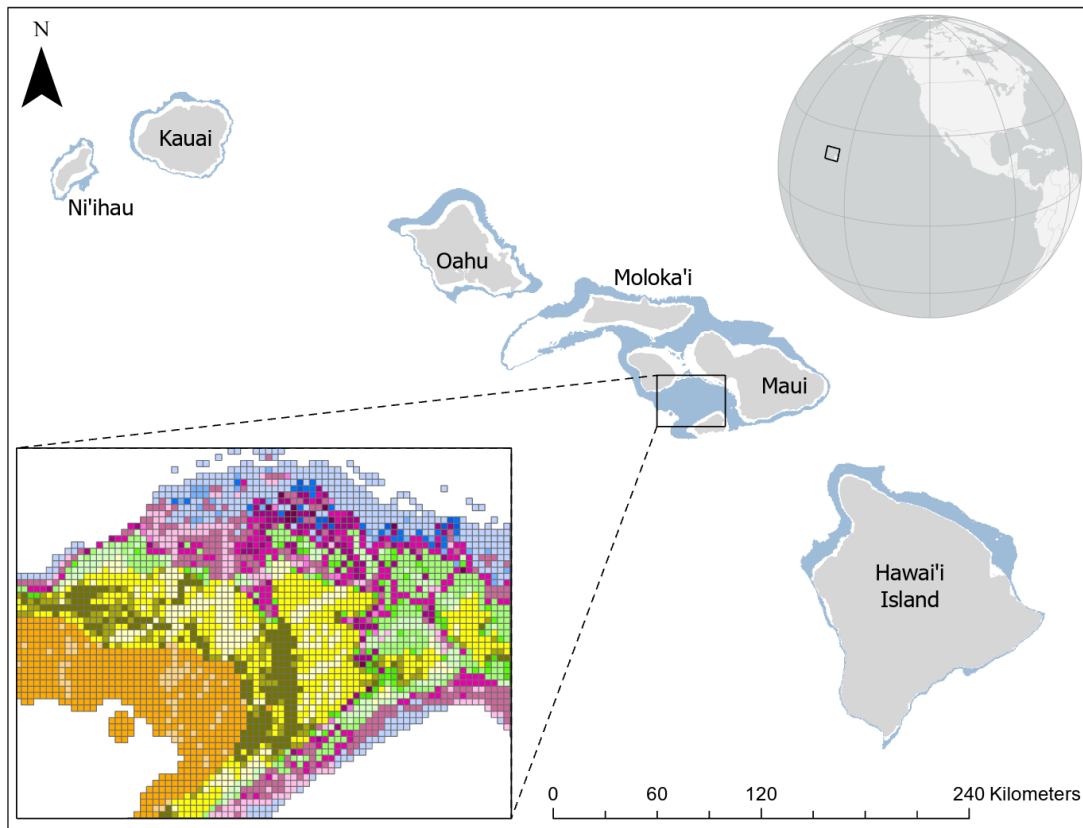
Figure 2. Spatial domain of the Bottomfish-Fishery Independent Survey in Hawaii (BFISH) (blue shaded region) with inset depicting 500 × 500 m grids near the island of Maui.

BFISH uses two survey gears: (1) hook-and-line research fishing parallel to what is used in the commercial fishery; and (2) remote drop MOUSS stereo-video cameras (Richards et al. 2016; Amin et al. 2017). A standard research fishing sample entailed 30 minutes of active hook-line fishing within a specified PSU by one vessel using two lines, each with four hooks and two bait types, i.e., squid and fish. Every fish captured was identified to species, and fork length (FL) was measured to the nearest cm. All Deep 7 individuals were retained and transferred to the PIFSC Fisheries Research and Monitoring Division (FRMD) Life History Program (LHP) for age, growth, sexual maturity, and genetic studies. Two randomized replicate 15-minute stationary camera deployments were conducted within each allocated PSU. In-situ footage from each deployment was analyzed to generate species-level counts by the MaxN method (Cappo et al. 2006) with individuals measured to the nearest mm FL. The two replicate counts were averaged for each allocated PSU.

The 2022 BFISH was conducted from 31 July to 31 November 2022 and employed the 2020 24-strata sampling scheme dependent on three principal environmental characteristics: (1) depth; (2) benthic habitat complexity; and (3) seafloor hardness (Table 1a and Table 1b). Depths and seafloor hardness were obtained from 5-m resolution multibeam bathymetry (Hawaii Mapping Research Group 2016). Habitat complexity was defined using computed arc chord ratio (ACR) values derived from the multibeam bathymetry. Seafloor habitat hardness was obtained from associated multibeam backscatter (Richards et al. 2019).

Survey sampling effort survey requirements were evaluated for optimal allocations amongst the 24 survey strata using a theoretical Neyman allocation method (Cochran 1977). Sample allocation was carried out in two steps: (1) determination of optimal allocation across a range of possible CVs for each of the three design species (ehu, opakapaka, onaga) that comprise more than 85% of the MHI commercial catches; (2) these species-specific allocations, evaluated at a target CV, were then compared to generate a composite allocation for the 2022 BFISH survey, paying particular attention to strata common to all species while also incorporating strata important to any one of the three design species.

Table 1a. Strata depth-habitat components and island-based PSU allocations of 2022 BFISH based on the refined 24-strata design.

Stratum	Substrata			2022 Island PSU Allocation					
	Depth	Complexity	Hardness	Niʻihau	Kauaʻi	Oʻahu	Maui Nui	Big Island	Total
S01	D1	MA1 OR MA2	HB1 OR HB2 OR HB3	2	3	4	17	4	30
S02	D1	MA3	HB1	2	3	5	5	8	23
S03	D1	MA3	HB2		2	2	2	2	8
S04	D1	MA3	HB3			2	2	2	6
S05	D2	MA1	HB1 OR HB2	2	2	2	19	5	30
S06	D2	MA1	HB3		2	2	4	2	10
S07	D2	MA2	HB1	2	2	2	22	7	35
S08	D2	MA2	HB2			3	8	6	17
S09	D2	MA2	HB3		2	2	2	2	8
S10	D2	MA3	HB1	2	2	3	16	12	35
S11	D2	MA3	HB2		2	5	12	9	28
S12	D2	MA3	HB3	2	2	2	4	17	27
S13	D3	MA1 OR MA2	HB1 OR HB2 OR HB3		2	2	11	3	18
S14	D3	MA3	HB1	2	2	2	11	6	23
S15	D3	MA3	HB2			3	8	3	14
S16	D3	MA3	HB3	2	2	3	6	12	25
S17	D4	MA1 OR MA2	HB1 OR HB2	2	2	2	3	2	11
S18	D4	MA1	HB3				8	2	10
S19	D4	MA2	HB3			3	15	2	20
S20	D4	MA3	HB1	2	3	6	25	17	53
S21	D4	MA3	HB2	2	3	6	14	8	33
S22	D4	MA3	HB3	4	4	18	29	20	75
S23	D5	MA1 OR MA2	HB1 OR HB2 OR HB3		2	2	2	2	8
S24	D5	MA3	HB1 OR HB2 OR HB3	3	3	9	16	22	53
		GRAND TOTAL		29	45	90	261	175	600

Table 1b. Habitat-based substrata components used in the 24-strata design.

Depth Substrata	Median Depth (m)	Complexity Substrata	Median ACR	Hardness Substrata	% of PSU px above multibeam backscatter value 136
D1	≥ 75 & < 110	MA1	< 4	HB1	< 0.24
D2	≥ 110 & < 170	MA2	>= 4 & < 9	HB2	>= 0.24 & < 0.46
D3	≥ 170 & <220	MA3	>= 9	HB3	>= 0.46
D4	≥ 200 & < 330				
D5	≥ 330 & < 400				

PSU within strata were randomly selected without replacement from a discrete uniform probability distribution to ensure an equal probability of selection (Law and Kelton 2000). The *effective survey sample size* used in abundance and biomass computations is the number of PSUs sampled within the preferred depth range for a given species. Domain mapping and survey sample site selection were conducted using ArcGIS (ESRI Inc. 2017) and R (R Development Core Team 2020). Gears were allocated to specific PSUs based on a combination of effective operational gear-depths (e.g., cameras ineffective > 250 m), logistical constraints, and regulatory restrictions (i.e., cameras allocated to PSUs where extractive fishing was prohibited). The relative effective fishing power of the two survey gears were inter-calibrated with a novel two-stage generalized linear regression model parameterized from comparative field data experiments where the two survey gears were simultaneously fished in the same time-space PSUs (Robson 1961; Richards et al. 2016). The observations were standardized relative to the camera gear.

The number of fish either caught (fishing) or seen (cameras) per unit sample area searched (i.e., density) was the principal metric used to develop the sampling design. Deep 7 species' population abundance and biomass estimation procedures followed statistical protocols for stratified random sampling designs (Cochran 1977; Ault et al. 1999; Lohr 2010; Smith et al. 2011; Ault et al. 2018). In general, estimation of population biomass B entailed expanding the mean biomass obtained per unit area searched, $\overline{U}_B$, to the full survey frame (Ault et al. 2018),

$$B = \overline{U}_B \frac{A_i}{a_i} G \tag{1}$$

where, A_i is the area of a grid cell sample unit, a_i is the effective sampling area (Ault et al. 2018) of the camera gear, and G is the number of grid cells in the survey domain. Mean biomass per sampled PSU was obtained by converting all lengths in the frequency distribution to weight following an allometric weight-length function, then summing the weights for all observed fish by species. Allometric weights dependent on length equations were developed for each Hawaiian Deep 7 species by scientists at the PIFSC (Ault et al. 2018). All computations were carried out using the R software package (R Development Core Team 2020).

Results

Sampling effort decreased from 751 PSU in 2021 to 600 in 2022. This decrease was made according to optimal sampling effort calculations from the expanded 2021 sampling effort, which indicated that sampling ~500 PSU would likely achieve the desired coefficient of variation (CV) for the three design species as well as result in cost savings. Given questions of vessel availability in 2022, a buffer of 100 PSU was added. In 2022, Pacific Islands Fisheries Group (PIFG) research hook-and-line sampling was conducted at 400 (Figure 3) PSUs from 2 Aug to 30 Nov 2022 (Appendix 2). In addition, camera sampling was conducted at 200 PSU around all eight main Hawaiian Islands from 31 July to 3 Oct. Camera sampling was conducted by PIFG from 31 July to 30 Aug and by the NOAA Ship *Oscar Elton Sette* and its small boats from 12 Sept to 3 Oct. (Appendix 3). Total survey sampling effort ($n = 600$) covered approximately 2.5% of PSUs.

Accurate length measurements were obtainable for all 632 Deep 7 individuals captured during research fishing operations and for 265 of the 360 (74%) fishes observed by the cameras (Table 2). A complete list of species captured during research fishing is provided in Appendix 1.
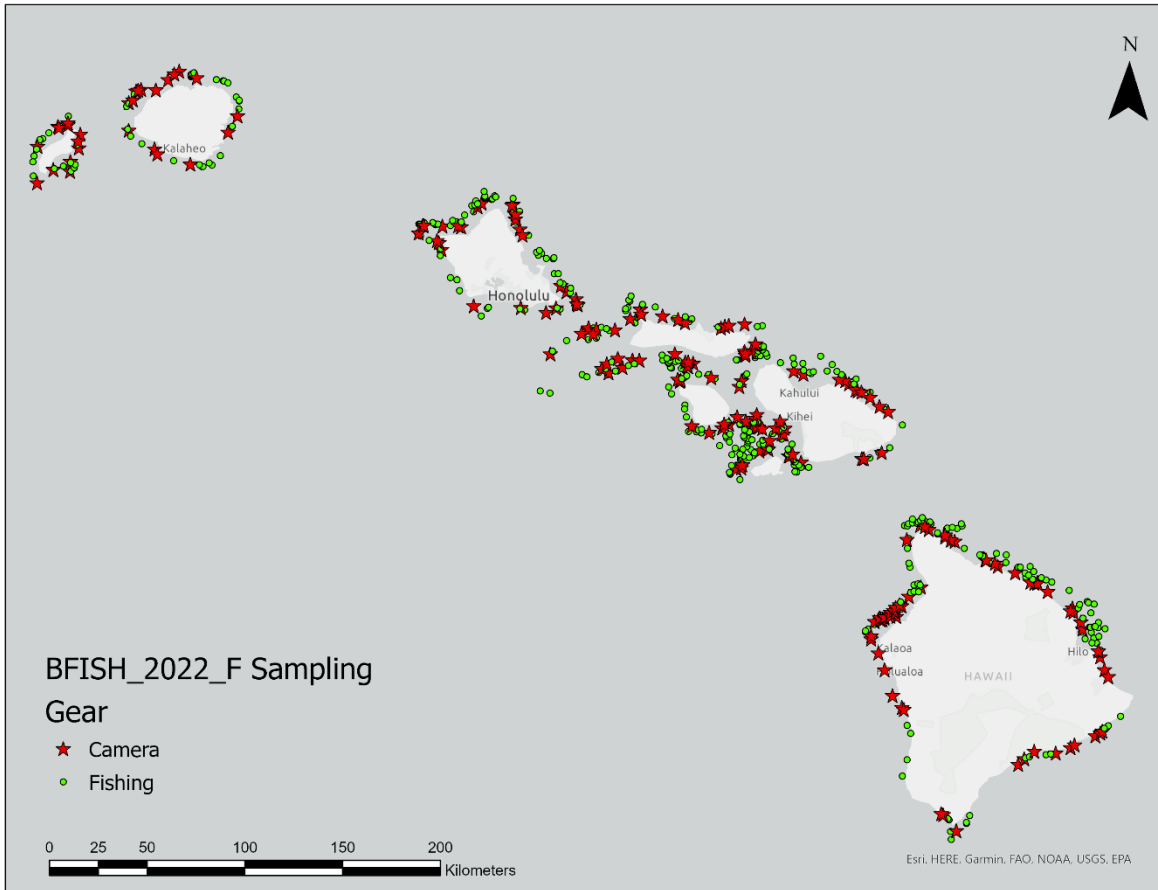
Figure 3. Map of 2022 BFISH sampling locations by gear type. Research fishing operations (green circles, *n* = 400) extended from the big island of Hawai'i in the southeast to Ni'ihau in the northwest. Camera operations (red stars, *n* = 200) were conducted around all islands except Ni'ihau and Kaua'i.

Table 2. Deep 7 species size ranges (cm FL) caught by research fishers or observed by cameras during the 2022 BFISH survey.

Species	n	Min	Mean	Max	SD	MaxN	measured	Min	Mean	Max	SD
		RESEARCH FISHING				MOUSS CAMERA					
Ehu	196	14.8	32.3	81.0	8.9	28	27	28.7	43.0	59.5	6.7
Gindai	26	19.0	30.5	40.0	5.3	29	8	19.1	31.1	41.3	6.7
Hapuʻupuʻu	2	52.0	57.5	63.0	7.8	1	1	91.1	91.1	91.1	-
Kalekale	33	21.0	34.9	54.0	5.4	199	131	14.4	30.9	76.2	8.5
Lehi	0	-	-	-	-	62	48	32.6	54.8	94.2	13.1
Onaga	39	27.5	43.5	76.0	10.9	0	0	-	-	-	-
Opakapaka	99	18.0	30.4	69.0	8.2	388	323	7.6	36.6	85.4	17.9
TOTAL Deep 7	**395**					**707**	**538**				

Table 3. Estimates of stock sizes for Deep 7 species from the 2022 BFISH survey: stock density (numbers per unit search area), exploited phase(≥ 29 cm FL) abundance (numbers), and biomass (kilograms).

Species	Density	SE	Abundance	SE	Biomass	SE	CV (%)
Opakapaka	0.2315	0.0470	570,930.4	115,982.1	892,982.7	152,684.3	20.31
Lehi	0.2113	0.0809	521,103.1	199,420.8	433,343.7	158,671.2	38.27
Ehu	0.1620	0.0241	399,585.2	59,440.0	384,115.6	70,133.3	14.88
Kalekale	0.0663	0.0212	163,532.1	52,368.9	275,898.8	81,123.8	32.02
Onaga	0.0209	0.0065	51,467.7	16,086.6	120,024.0	33,365.1	31.26
Hapuʻupuʻu	0.0144	0.0051	35,532.3	12,490.1	29,332.8	9,730.7	35.15
Gindai	0.0025	0.0015	6,075.3	3,797.2	56,257.5	45,942.4	62.50
TOTAL					2,191,955.1	251,609.6	11.48

Trends in exploited phase stock biomass varied among species, but—with the possible exception of ehu—showed little variation among years within species (Table 4, Figure 4) and little change in species-specific size distributions (Figure 5). Survey precision ranged from a CV of 14.9% for ehu to 62.5% for hapuʻupuʻu, with CVs of 20.3% and 32.0% for opakapaka and onaga, respectively (Table 3, Figure 6).

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Table 4. Exploited phase (≥ 29 cm FL) abundance (numbers) and biomass estimates for Deep 7 species from 2016–2022 BFISH surveys.

	Year	No. of Strata	n	CPUE, number Mean	SE	CPUE, biomass (kg) Mean	SE	Abundance (number) Total	SE	Biomass (kg) Total	SE	CV%
Ehu	2016	9	319	0.3821	0.0711	0.3728	0.0737		175,428	919,452	181,683	18.62
	2017	9	449	0.3145	0.0901	0.3496	0.1020	775,717	222,139	862,203	251,494	28.64
	2018	9	437	0.2198	0.0565	0.2508	0.0721	541,935	139,395	618,476	177,760	25.72
	2019	9	470	0.3848	0.0683	0.3938	0.0769	948,935	168,360	971,152	189,688	17.74
	2020	24	499		0.0680	0.3577	0.0616	936,341	167,740	882,078	151,840	17.90
	2021	24	747	0.2541	0.0337	0.2462	0.0383	626,640	83,141	607,138	94,505	13.27
	2022	24	596	0.1620	0.0241	0.1558	0.0284	399,585	59,440	384,116	70,133	14.88
Gindai	2016	9	326	0.0213	0.0072	0.0209	0.0076	52,590	17,855	51,604	18,835	33.95
	2017	9	448	0.0132	0.0043	0.0137	0.0044	32,508	10,489	33,816	10,847	32.27
	2018	9	441	0.0118	0.0050	0.0128	0.0052	29,186	12,215	31,641	12,907	
	2019	9	475	0.0212	0.0063	0.0227	0.0078	52,354	15,459	55,896	19,149	29.53
	2020	24	499	0.0694	0.0167	0.0707	0.0184	171,151	41,152	174,479	45,378	24.00
	2021	24	746	0.0258	0.0051	0.0224	0.0046	63,603	12,641	55,142	11,346	19.87
	2022	24	594	0.0144	0.0051	0.0119	0.0039	35,532	12,490	29,333	9,731	35.15
Hapuʻupuʻu	2016	9	327	0.0067	0.0040	0.0556	0.0330	16,507	9,918	137,132	81,386	60.09
	2017	9	447	0.0070	0.0028	0.0389	0.0173	17,240	6,938	95,833	42,768	40.24
	2018	9	441	0.0198	0.0082	0.1018	0.0408	48,949	20,183	251,133	100,586	41.23
	2019	9	475	0.0047	0.0026	0.0226	0.0119	11,607	6,433	55,660	29,226	55.42
	2020	24	499	0.0141	0.0053	0.0861	0.0348	34,655	13,051	212,322	85,781	37.70
	2021	24	747	0.0060	0.0021	0.0279	0.0103	14,832	5,080	68,828	25,343	34.25
	2022	24	596	0.0025	0.0015	0.0228	0.0186	6,075	3,797	56,258		62.50
Kalekale	2016	9	319	0.1636	0.0459	0.1500	0.0435	403,394	113,100	369,934	107,307	28.04
	2017	9	441	0.5378	0.1088	0.4653	0.0948	1,326,264	268,416	1,147,403	233,870	20.24
	2018	9	440	0.2534	0.0706	0.2301	0.0638	624,930	174,137	567,353	157,460	27.86
	2019	9	475	0.2306	0.0824	0.2007	0.0742	568,660	203,191	495,057	182,942	35.73
	2020	24	499	0.4152	0.1383	0.3171	0.1008	1,024,052	341,019	781,899	248,643	33.30
	2021	24	747	0.2708	0.0840	0.2193	0.0684	667,778	207,094	540,709	168,723	31.01
	2022	24	596	0.2113	0.0809	0.1757	0.0643	521,103	199,421	433,344	158,671	38.27
Lehi	2016	9	325	0.0185	0.0123	0.0690	0.0514	45,733	30,332	170,059	126,670	66.32
	2017	9	444	0.0285	0.0158	0.0746	0.0441	70,270	38,934	184,039	108,741	55.41
	2018	9	438	0.0181	0.0137	0.0561	0.0425	44,580	33,811	138,280	104,872	75.84
	2019	9	475	0.0033	0.0020	0.0130	0.0084	8,110	4,936	32,018	20,629	60.87
	2020	24	499	0.0035	0.0025	0.0096	0.0066	8,751	6,281	23,624	16,358	71.80
	2021	24	747	0.0576	0.0454	0.2698	0.2265	142,114	111,902	665,448	558,569	78.74
	2022	24	595	0.0209	0.0065	0.0487	0.0135	51,468	16,087	120,024	33,365	

Onaga	2016	9	326	0.0728	0.0269	0.1830	0.0872	179,630	66,349	451,310	214,947	36.94
	2017	9	444	0.1720	0.0594	0.4290	0.1599	424,187	146,603	1,057,903	394,391	34.56
	2018	9	441	0.0665	0.0244	0.1654	0.0701	164,059	60,274	408,004	172,812	36.74
	2019	9	475	0.0509	0.0230	0.2163	0.1049	125,554	56,670	533,442	258,800	45.14
	2020	24	499	0.0762	0.0193	0.1360	0.0404	188,001	47,576	335,386	99,570	25.30
	2021	24	747	0.0553	0.0125	0.1056	0.0243	136,324	30,922	260,303	59,886	22.68
	2022	24	596	0.0663	0.0212	0.1119	0.0329	163,532	52,369	275,899	81,124	32.02
Opakapaka	2016	9	319	0.6877	0.2293	1.5231	0.5297	1,695,941	565,522	3,756,272	1,306,338	33.35
	2017	9	438	0.4057	0.0901	0.8600	0.1659	1,000,451	222,237	2,120,883	409,208	22.21
	2018	9	436	0.2435	0.0715	0.5633	0.1579	600,414	176,402	1,389,282	389,363	29.38
	2019	9	472	0.2730	0.0627	0.5984	0.1454	673,334	154,681	1,475,671	358,653	22.97
	2020	24	499	0.2796	0.0902	0.4295	0.1182	689,596	222,375	1,059,126	291,476	32.30
	2021	24	747	0.2710	0.0416	0.5141	0.1009	668,353	102,626	1,267,922	248,822	15.36
	2022	24	594	0.2315	0.0470	0.3621	0.0619	570,930	115,982	892,983	152,684	20.31
Deep 7	2016	9								5,855,762	1,349,173	23.04
	2017	9								5,502,080	674,323	12.26
	2018	9								3,404,169	509,060	14.95
	2019	9								3,618,897	516,435	14.27
	2020	24								3,468,915	435,243	12.55
	2021	24								3,465,490	644,723	18.60
	2022	24								2,191,955	251,610	11.48

Species	Year	No. of Strata	n	CPUE, number Mean	SE	CPUE, biomass (kg) Mean	SE	Abundance (number) Total	SE	Biomass (kg) Total	SE	CV%
Ehu	2016	9	319	0.3821	0.0711	0.3728	0.0737	942,393	175,428	919,452	181,683	18.62
	2017	9	449	0.3145	0.0901	0.3496	0.1020	775,717	222,139	862,203	251,494	28.64
	2018	9	437	0.2198	0.0565	0.2508	0.0721	541,935	139,395	618,476	177,760	25.72
	2019	9	470	0.3848	0.0683	0.3938	0.0769	948,935	168,360	971,152	189,688	17.74
	2020	24	499	0.3797	0.0680	0.3577	0.0616	936,341	167,740	882,078	151,840	17.90
	2021	24	747	0.2541	0.0337	0.2462	0.0383	626,640	83,141	607,138	94,505	13.27
	2022	24	596	0.1620	0.0241	0.1558	0.0284	399,585	59,440	384,116	70,133	14.88
Gindai	2016	9	326	0.0213	0.0072	0.0209	0.0076	52,590	17,855	51,604	18,835	33.95
	2017	9	448	0.0132	0.0043	0.0137	0.0044	32,508	10,489	33,816	10,847	32.27
	2018	9	441	0.0118	0.0050	0.0128	0.0052	29,186	12,215	31,641	12,907	41.85
	2019	9	475	0.0212	0.0063	0.0227	0.0078	52,354	15,459	55,896	19,149	29.53
	2020	24	499	0.0694	0.0167	0.0707	0.0184	171,151	41,152	174,479	45,378	24.00
	2021	24	746	0.0258	0.0051	0.0224	0.0046	63,603	12,641	55,142	11,346	19.87
	2022	24	594	0.0144	0.0051	0.0119	0.0039	35,532	12,490	29,333	9,731	35.15
Hapuʻupuʻu	2016	9	327	0.0067	0.0040	0.0556	0.0330	16,507	9,918	137,132	81,386	60.09
	2017	9	447	0.0070	0.0028	0.0389	0.0173	17,240	6,938	95,833	42,768	40.24
	2018	9	441	0.0198	0.0082	0.1018	0.0408	48,949	20,183	251,133	100,586	41.23
	2019	9	475	0.0047	0.0026	0.0226	0.0119	11,607	6,433	55,660	29,226	55.42
	2020	24	499	0.0141	0.0053	0.0861	0.0348	34,655	13,051	212,322	85,781	37.70
	2021	24	747	0.0060	0.0021	0.0279	0.0103	14,832	5,080	68,828	25,343	34.25
	2022	24	596	0.0025	0.0015	0.0228	0.0186	6,075	3,797	56,258	45,942	62.50
Kalekale	2016	9	319	0.1636	0.0459	0.1500	0.0435	403,394	113,100	369,934	107,307	28.04
	2017	9	441	0.5378	0.1088	0.4653	0.0948	1,326,264	268,416	1,147,403	233,870	20.24
	2018	9	440	0.2534	0.0706	0.2301	0.0638	624,930	174,137	567,353	157,460	27.86
	2019	9	475	0.2306	0.0824	0.2007	0.0742	568,660	203,191	495,057	182,942	35.73
	2020	24	499	0.4152	0.1383	0.3171	0.1008	1,024,052	341,019	781,899	248,643	33.30
	2021	24	747	0.2708	0.0840	0.2193	0.0684	667,778	207,094	540,709	168,723	31.01
	2022	24	596	0.2113	0.0809	0.1757	0.0643	521,103	199,421	433,344	158,671	38.27
Lehi	2016	9	325	0.0185	0.0123	0.0690	0.0514	45,733	30,332	170,059	126,670	66.32
	2017	9	444	0.0285	0.0158	0.0746	0.0441	70,270	38,934	184,039	108,741	55.41
	2018	9	438	0.0181	0.0137	0.0561	0.0425	44,580	33,811	138,280	104,872	75.84
	2019	9	475	0.0033	0.0020	0.0130	0.0084	8,110	4,936	32,018	20,629	60.87
	2020	24	499	0.0035	0.0025	0.0096	0.0066	8,751	6,281	23,624	16,358	71.80
	2021	24	747	0.0576	0.0454	0.2698	0.2265	142,114	111,902	665,448	558,569	78.74
	2022	24	595	0.0209	0.0065	0.0487	0.0135	51,468	16,087	120,024	33,365	31.26

Onaga	2016	9	326	0.0728	0.0269	0.1830	0.0872	179,630	66,349	451,310	214,947	36.94
	2017	9	444	0.1720	0.0594	0.4290	0.1599	424,187	146,603	1,057,903	394,391	34.56
	2018	9	441	0.0665	0.0244	0.1654	0.0701	164,059	60,274	408,004	172,812	36.74
	2019	9	475	0.0509	0.0230	0.2163	0.1049	125,554	56,670	533,442	258,800	45.14
	2020	24	499	0.0762	0.0193	0.1360	0.0404	188,001	47,576	335,386	99,570	25.30
	2021	24	747	0.0553	0.0125	0.1056	0.0243	136,324	30,922	260,303	59,886	22.68
	2022	24	596	0.0663	0.0212	0.1119	0.0329	163,532	52,369	275,899	81,124	32.02
Opakapaka	2016	9	319	0.6877	0.2293	1.5231	0.5297	1,695,941	565,522	3,756,272	1,306,338	33.35
	2017	9	438	0.4057	0.0901	0.8600	0.1659	1,000,451	222,237	2,120,883	409,208	22.21
	2018	9	436	0.2435	0.0715	0.5633	0.1579	600,414	176,402	1,389,282	389,363	29.38
	2019	9	472	0.2730	0.0627	0.5984	0.1454	673,334	154,681	1,475,671	358,653	22.97
	2020	24	499	0.2796	0.0902	0.4295	0.1182	689,596	222,375	1,059,126	291,476	32.30
	2021	24	747	0.2710	0.0416	0.5141	0.1009	668,353	102,626	1,267,922	248,822	15.36
	2022	24	594	0.2315	0.0470	0.3621	0.0619	570,930	115,982	892,983	152,684	20.31
Deep 7	2016	9								5,855,762	1,349,173	23.04
	2017	9								5,502,080	674,323	12.26
	2018	9								3,404,169	509,060	14.95
	2019	9								3,618,897	516,435	14.27
	2020	24								3,468,915	435,243	12.55
	2021	24								3,465,490	644,723	18.60
	2022	24								2,191,955	251,610	11.48

Figure 4. Standard-normal distribution of exploited phase (≥ 29 cm FL) stock biomass for the Deep 7 complex by species and year.
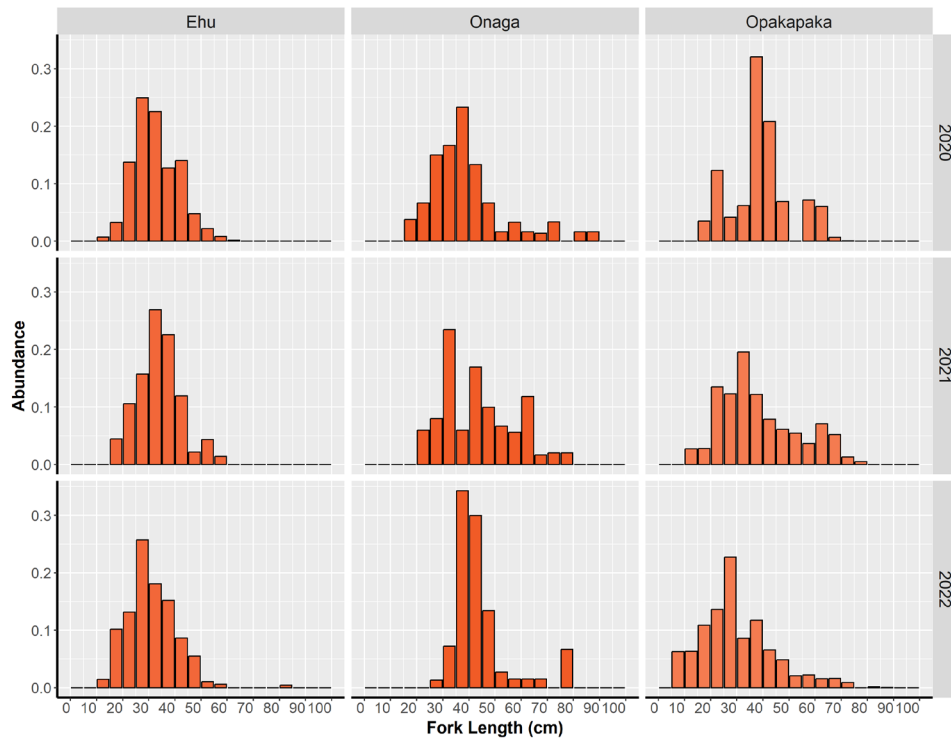
Figure 5. Length frequencies for opakapaka, onaga, and ehu from the 2020–2022 BFISH surveys based on combined research fishing and MOUSS camera data, under the revised 24-strata design. Exploited phase is ≥ 29 cm FL.
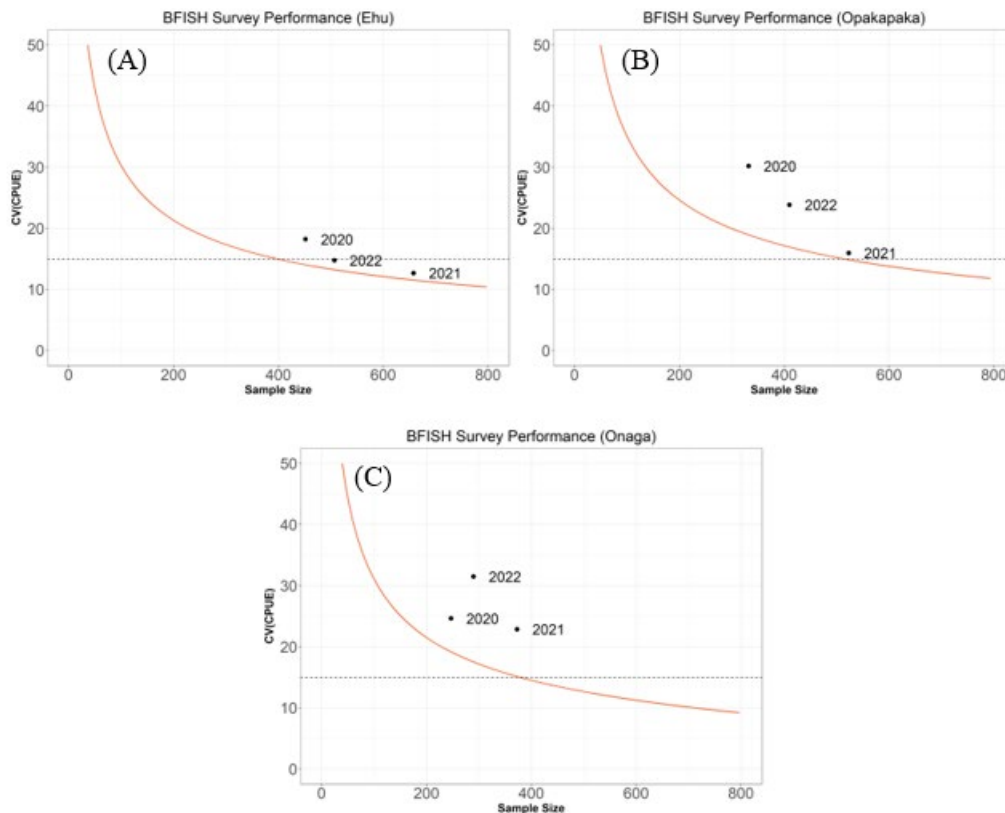
Figure 6. Species-specific 2020-2022 survey performance (coefficient of variation [CV] of population density) versus required sample size using Neyman allocation (orange curve) for the three BFISH design species: (A) ehu; (B) opakapaka; and (C) onaga. Target CV of 15% is indicated by the dashed horizontal line.

Discussion

The 2022 BFISH mission marks the seventh year of the operational survey that provides accurate and precise species-specific fishery-independent estimates of size-structured abundance and biomass for use in Deep 7 bottomfish stock assessments. BFISH continues to represent a state-of-the art, effective public-private and cooperative-research partnership between the Pacific Islands Fisheries Science Center (PIFSC), the Pacific Islands Fisheries Group (PIFG), and the University of Miami (UM). During the height of the COVID 19 pandemic, BFISH surveys were conducted entirely by PIFG cooperative research fishers, without direct field support by PIFSC staff or NOAA research vessels. In 2022, the NOAA Ship *Oscar Elton Sette* returned to survey operations, providing a valuable platform for camera deployments as well as research and development of new survey gear, like the artificial light model and the Robot Operating System (ROS) for future iterations of the MOUSS.

BFISH 2022 estimated the exploited Deep 7 complex biomass as 4.83 million lb, suggesting that the 492,000 lb 2021 ACL allocated by the WPRFMC could represent approximately 10.2% of the exploited biomass. While the 4.83 million lb biomass estimate for 2022 represents a 37%

decrease from the 7.64 million lb 2021 biomass estimate, trends in the principal fishery species (opakapaka, ehu, and onaga) appear relatively stable over the 2016–2022 time period (Figure 4). The high 2021 lehi biomass estimate of 1.467 million lb dropped to 0.26 million lb in 2022, in line with prior year averages. Biomass estimates for ehu have been declining since 2019 (Figure 4), a trend that continued in 2022 and which may now represent a significant decline. Detailed analysis of this apparent decline, as well as any impacts on the overall stock, are and will be discussed in past and upcoming main Hawaiian Islands Deep 7 stock assessments. Patterns in species-specific abundance inform stock assessments for the main Hawaiian Islands Deep 7 complex (Syslo et al. 2021), and single-species research assessments are planned for the future (Syslo et al. 2022).

Since its inception, the strategy of the BFISH sampling design has focused on achieving a high level of precision for the three principal design species (i.e., ehu, opakapaka, and onaga). This is because these three species constitute 85% of the reported commercial catches. Between 2016 and 2019 using the 9-strata survey design, CVs averaged 22.68%, 38.35%, and 26.98% for ehu, onaga, and opakapaka, respectively. In 2020, the survey was refined to a 24-strata design which has resulted in significant reductions in sampling effort required to achieve a particular CV.

In 2021, BFISH sampling effort increased to 751 PSU (or "grid-cells"), expressly to determine future sampling levels required to achieve a desired CV of leadership and assessment decision-makers. For the three design species (ehu, opakapaka, and onaga), the 2021 BFISH achieved CVs of 13.27%, 15.36%, and 22.68%, respectively (Table 3, Figure 6).

The refinement of the survey design over time using a strategy of "iterative learning" (Ault et al. 2005) has allowed substantial improvements in survey precision at reduced costs (i.e., less sampling effort), evidenced by the left and downward shifts of the species-specific Neyman curves (Figures 6 & 7). Analysis of the 2021 BFISH suggest that 335, 423, and 434 PSU are needed to achieve a 15% CVs for ehu, opakapaka, and onaga, respectively, representing a 34–57% reduction in sampling effort and cost savings (Figure 7, Table 5). It would appear that use of the current composite survey design, and sample allocation of approximately 500 PSU, is likely sufficient for future surveys to achieve a 15% CV.

Based on these results, the 2022 BFISH sampling effort allocated 500 PSU for cooperative research sampling (hook-and-line and camera). An additional 100 PSU were allocated to the NOAA Ship *Oscar Elton Sette*. However, as the availability of the *Sette* remained uncertain throughout the project design phase, these PSU were added to, rather than subtracted from, the cooperative research allocation.
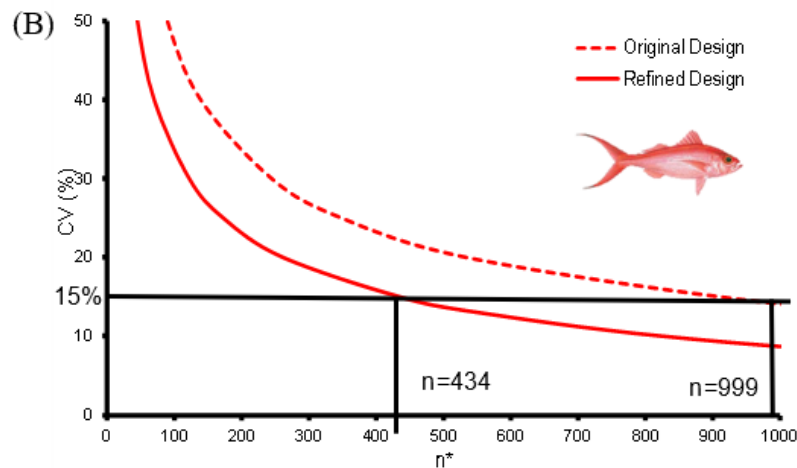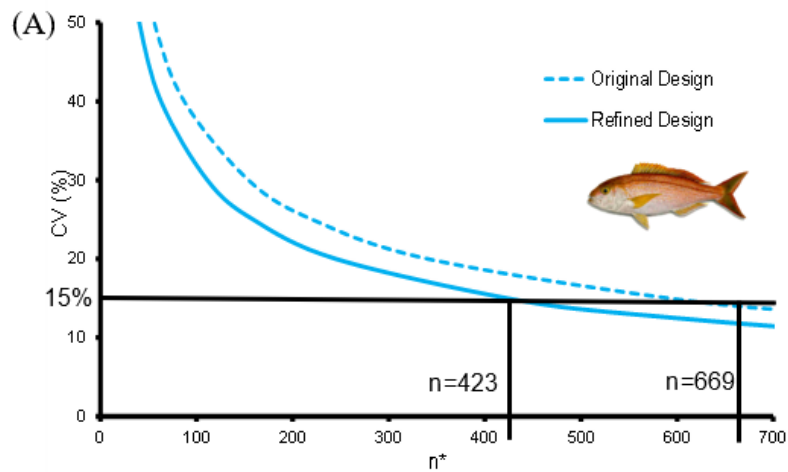
Figure 7. Comparison of Neyman allocation curves (blue and orange curves) for the original 9-strata (used in 2016–2019; dashed line) and refined 24 strata (2020–2021; solid line) survey designs. Horizontal line shows the number of PSU samples (*n**) required to achieve 15% CV for each design: (A) opakapaka and (B) onaga.

Table 5. Number of PSU samples required to achieve a 15% CV for each primary species under the original 9- and refined 24-strata BFISH designs.

	BFISH Design Strata		%
Species	**9**	**24**	**Reduction**
Ehu	508	335	34
Opakapaka	669	423	37
Onaga	999	434	57

BFISH remains a continual iterative learning and design process, striving to reduce sampling effort and cost to achieve optimal data for the stock assessment process. Future research should focus on technical improvements to the cameras, specifically on determination of effective camera sampling area (Bohaboy et al. 2020; Dahl and Patterson 2020) and extending the depth range of cameras to encompass the full 75-400 m depth range of the stock using non-obtrusive artificial lighting (Widder et al. 2005; Raymond and Widder 2007; Fitzpatrick et al. 2013; Rooper et al. 2015; Barker and Cowan 2018; Birt et al. 2019).

BFISH has matured to the point where established methodologies may now begin to expand to other U.S. Pacific Territories where fishery-independent survey data may benefit associated stock assessments. Efficient expansion is predicated on (1) genetic studies that can be used to define stock domains and (2) comprehensive, high-resolution bathymetric mapping and derived products that can be used to develop an efficient stratification of the stock domain for survey design and allocation.

Acknowledgements

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Appendices

Appendix 1. Numbers (n) of individual fish (Deep 7 and other species) caught during 2022 BFISH research fishing operations.

Species Code	Common Name	Scientific Name	n
Deep 7			**395**
ETCA	Ehu	*Etelis carbunculus*	196
PRFI	Opakapaka	*Pristipomoides filamentosus*	99
ETCO	Onaga	*Etelis coruscans*	39
PRSI	Kalekale	*Pristipomoides sieboldii*	33
PRZO	Gindai	*Pristipomoides zonatus*	26
HYQU	Hapu'upu'u	*Hyporthodus quernus*	2
APRU	Lehi	*Aphareus rutilans*	0
non-Deep 7			**399**
SQSP	Green eye shark	*Squalus sp.*	207
SEDU	Greater amberjack	*Seriola dumerili*	44
POMA	Large-headed scorpionfish	*Pontinus macrocephalus*	13
BOAL	Hawaiian hogfish	*Bodianus albotaeniatus*	12
LUKA	Bluestripe snapper	*Lutjanus kasmira*	11
POBE	Beardfish	*Polymixia berndti*	10
SHRK	Shark sp.	*Chondrichthid sp.*	9
SPPA	Blunthead puffer	*Sphoeroides pachygaster*	4
APVI	Green jobfish	*Aprion virescens*	3
ANSP	BOAR Fish	*Antigonia sp.*	2
BEDA	Al FONSIN	*Beryx decadactylus*	2
CAOR	Island trevally	*Carangoides orthogrammus*	2
EESP	Eel sp.	*Anguilliformes sp.*	2
MUPF	Orange goatfish	*Mulloidichthys pfluegeri*	2
PSAU	Yellowtail opakapaka	*Pristipomoides auricilla*	2
AKUU	Skipjack tuna	*Katsuwonus pelamis*	1
CALU	Gukhan	*Caranx lugubris*	1
CAPL	Sandbar shark	*Carcharhinus plumbeus*	1
CHCH	green-spotted duckbill	*Chrionema chryseres*	1
COSP	Coelorinchus spilonotus	*Coelorinchus spilonotus*	1
DASY	Stingray sp.	*Dasyatidae sp.*	1
GYSP	Moray eel	*Gymnothorax sp.*	1
MASP	Rattail	*Macrourid sp.*	1
SARD	Bonito	*Sarda sp.*	1
SERI	Almaco jack	*Seriola rivoliana*	1
SUFR	Bridled Triggerfish	*Sufflamea fraenatum*	1
SYLO	Lobel's lizardfish	*Synodus lobeli*	1
TRMY	Lizard Fish	*Trachinocephalus myhops*	1
XACA	Bluelined triggerfish	*Xanthichthys caeruleolineatus*	1
	Grand Total		**734**

Appendix 2. Primary sampling units (PSU) sampled by hook-and-line fishing gear during the 2021 BFISH with location, stratum, and vessel.

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
8/18/2022	Maui Nui	14878	20.705257	-156.966383	S22	Naomi K	Fishing
8/18/2022	Maui Nui	15139	20.714230	-156.961464	S10	Naomi K	Fishing
8/18/2022	Maui Nui	15274	20.718517	-156.942208	S01	Naomi K	Fishing
8/18/2022	Maui Nui	14753	20.700457	-156.942452	S21	Naomi K	Fishing
8/18/2022	Maui Nui	14764	20.699818	-156.889671	S21	Naomi K	Fishing
8/19/2022	Maui Nui	16008	20.735793	-156.538794	S01	Naomi K	Fishing
8/19/2022	Maui Nui	15618	20.722389	-156.548609	S07	Naomi K	Fishing
8/19/2022	Maui Nui	14966	20.699752	-156.544175	S07	Naomi K	Fishing
8/19/2022	Maui Nui	14450	20.681765	-156.549262	S21	Naomi K	Fishing
8/19/2022	Maui Nui	15086	20.704943	-156.592075	S05	Naomi K	Fishing
8/20/2022	Maui Nui	16285	20.753036	-156.812124	S08	Naomi K	Fishing
8/20/2022	Maui Nui	16899	20.779630	-156.773330	S02	Naomi K	Fishing
8/20/2022	Maui Nui	16190	20.747778	-156.754596	S07	Naomi K	Fishing
8/20/2022	Maui Nui	16079	20.743264	-156.754663	S07	Naomi K	Fishing
8/20/2022	Maui Nui	15970	20.738307	-156.721137	S11	Naomi K	Fishing
8/20/2022	Maui Nui	15449	20.720377	-156.731004	S10	Naomi K	Fishing
8/20/2022	Maui Nui	16416	20.755916	-156.687271	S07	Naomi K	Fishing
8/20/2022	Maui Nui	16420	20.755656	-156.668074	S12	Naomi K	Fishing
8/22/2022	Maui Nui	14665	20.693353	-156.736205	S20	Naomi K	Fishing
8/22/2022	Maui Nui	14412	20.684261	-156.731542	S20	Naomi K	Fishing
8/22/2022	Maui Nui	13793	20.662620	-156.803826	S24	Naomi K	Fishing
8/22/2022	Maui Nui	13295	20.645165	-156.852048	S24	Naomi K	Fishing
8/22/2022	Maui Nui	14270	20.680862	-156.817958	S22	Naomi K	Fishing
8/22/2022	Maui Nui	14396	20.685255	-156.808299	S22	Naomi K	Fishing
8/22/2022	Maui Nui	14518	20.689952	-156.822627	S22	Naomi K	Fishing
8/22/2022	Maui Nui	14782	20.698738	-156.803306	S21	Naomi K	Fishing
8/22/2022	Maui Nui	15192	20.711030	-156.707149	S20	Naomi K	Fishing
8/23/2022	Maui Nui	12571	20.613578	-156.516787	S07	Naomi K	Fishing
8/23/2022	Maui Nui	13077	20.632919	-156.607599	S14	Naomi K	Fishing
8/23/2022	Maui Nui	13235	20.636146	-156.516421	S14	Naomi K	Fishing
8/23/2022	Maui Nui	13707	20.655886	-156.636021	S15	Naomi K	Fishing
8/23/2022	Maui Nui	13857	20.658438	-156.496872	S07	Naomi K	Fishing
8/24/2022	Maui Nui	28270	21.062149	-156.629659	S05	Naomi K	Fishing
8/24/2022	Maui Nui	29042	21.075757	-156.634254	S18	Naomi K	Fishing
8/24/2022	Maui Nui	29717	21.089566	-156.653278	S19	Naomi K	Fishing
8/24/2022	Maui Nui	30043	21.098727	-156.662757	S19	Naomi K	Fishing
8/24/2022	Maui Nui	30357	21.112402	-156.672166	S18	Naomi K	Fishing
8/24/2022	Maui Nui	30154	21.103308	-156.667496	S19	Naomi K	Fishing
8/2/2022	Big Island	10017	20.313217	-155.813446	S22	AO Shibi IV	Fishing
8/2/2022	Big Island	9898	20.304107	-155.808849	S21	AO Shibi IV	Fishing
8/2/2022	Big Island	9357	20.262894	-155.776218	S01	AO Shibi IV	Fishing

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8/2/2022	Big Island	9302	20.258383	-155.776311	S02	AO Shibi IV	Fishing
8/2/2022	Big Island	9492	20.271118	-155.733008	S13	AO Shibi IV	Fishing
8/3/2022	Big Island	9678	20.284561	-155.727943	S22	AO Shibi IV	Fishing
8/3/2022	Big Island	9616	20.280140	-155.732819	S22	AO Shibi IV	Fishing
8/3/2022	Big Island	8974	20.221053	-155.710153	S07	AO Shibi IV	Fishing
8/3/2022	Big Island	9743	20.288623	-155.703945	S21	AO Shibi IV	Fishing
8/3/2022	Big Island	9688	20.283661	-155.680138	S24	AO Shibi IV	Fishing
8/3/2022	Big Island	9989	20.305849	-155.660532	S23	AO Shibi IV	Fishing
8/3/2022	Big Island	9871	20.296737	-155.655945	S24	AO Shibi IV	Fishing
8/3/2022	Big Island	8768	20.192722	-155.643835	S20	AO Shibi IV	Fishing
8/25/2022	Big Island	8481	20.166129	-155.438940	S24	AO Shibi IV	Fishing
8/25/2022	Big Island	7894	20.130053	-155.439759	S20	AO Shibi IV	Fishing
8/25/2022	Big Island	7877	20.131676	-155.520930	S10	AO Shibi IV	Fishing
8/25/2022	Big Island	8542	20.171600	-155.486597	S24	AO Shibi IV	Fishing
8/26/2022	Big Island	8384	20.164184	-155.567991	S20	AO Shibi IV	Fishing
8/26/2022	Big Island	8387	20.163904	-155.553663	S21	AO Shibi IV	Fishing
8/26/2022	Big Island	8317	20.159394	-155.553762	S20	AO Shibi IV	Fishing
8/27/2022	Big Island	1730	19.427690	-154.870542	S12	AO Shibi IV	Fishing
8/28/2022	Big Island	1625	19.383908	-154.928673	S22	AO Shibi IV	Fishing
8/28/2022	Big Island	1597	19.370811	-154.948006	S12	AO Shibi IV	Fishing
8/29/2022	Big Island	1185	19.256176	-155.283287	S21	AO Shibi IV	Fishing
8/29/2022	Big Island	1165	19.250106	-155.207428	S14	AO Shibi IV	Fishing
8/29/2022	Big Island	1133	19.246088	-155.231268	S20	AO Shibi IV	Fishing
8/29/2022	Big Island	1052	19.234207	-155.312279	S24	AO Shibi IV	Fishing
8/29/2022	Big Island	1031	19.230079	-155.331369	S22	AO Shibi IV	Fishing
8/30/2022	Big Island	7	18.848740	-155.685717	S22	AO Shibi IV	Fishing
8/30/2022	Big Island	199	18.924147	-155.613102	S22	AO Shibi IV	Fishing
8/30/2022	Big Island	212	18.928658	-155.613011	S11	AO Shibi IV	Fishing
8/30/2022	Big Island	316	18.959974	-155.598150	S22	AO Shibi IV	Fishing
8/30/2022	Big Island	63	18.884915	-155.689747	S12	AO Shibi IV	Fishing
8/15/2022	Maui Nui	31968	21.191806	-156.873131	S11	Naomi K	Fishing
8/15/2022	Maui Nui	31974	21.191440	-156.844248	S15	Naomi K	Fishing
8/15/2022	Maui Nui	32457	21.202482	-156.656313	S19	Naomi K	Fishing
8/15/2022	Maui Nui	32301	21.198300	-156.680451	S21	Naomi K	Fishing
8/16/2022	Maui Nui	30262	21.107556	-156.648184	S19	Naomi K	Fishing
8/16/2022	Maui Nui	30158	21.103042	-156.648255	S18	Naomi K	Fishing
8/18/2022	Maui Nui	14870	20.705706	-157.004773	S24	Naomi K	Fishing
8/18/2022	Maui Nui	15396	20.723543	-156.985339	S20	Naomi K	Fishing
9/24/2022	Oʻahu	37354	21.551611	-158.306604	S03	Ebisui III	Fishing
9/24/2022	Oʻahu	38428	21.628237	-158.267589	S22	Ebisui III	Fishing
8/6/2022	Oʻahu	36968	21.489182	-157.689130	S22	Renee NV	Fishing
8/6/2022	Oʻahu	36924	21.484704	-157.693996	S12	Renee NV	Fishing
8/6/2022	Oʻahu	36361	21.416882	-157.684953	S02	Renee NV	Fishing
8/6/2022	Oʻahu	36365	21.416730	-157.665660	S24	Renee NV	Fishing

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8/6/2022	Oʻahu	36072	21.376005	-157.656385	S17	Renee NV	Fishing
8/6/2022	Oʻahu	36030	21.371372	-157.641961	S20	Renee NV	Fishing
8/6/2022	Oʻahu	35860	21.352991	-157.603559	S24	Renee NV	Fishing
8/6/2022	Oʻahu	35670	21.330409	-157.603773	S08	Renee NV	Fishing
8/13/2022	Oʻahu	35525	21.325017	-158.148575	S15	Renee NV	Fishing
8/13/2022	Oʻahu	35992	21.374779	-158.162755	S10	Renee NV	Fishing
8/13/2022	Oʻahu	36079	21.383978	-158.196464	S22	Renee NV	Fishing
8/13/2022	Oʻahu	36846	21.483602	-158.249009	S24	Renee NV	Fishing
8/13/2022	Oʻahu	37014	21.501671	-158.248916	S21	Renee NV	Fishing
8/13/2022	Oʻahu	37121	21.515222	-158.248847	S21	Renee NV	Fishing
8/25/2022	Oʻahu	35045	21.294077	-157.580020	S02	Renee NV	Fishing
8/25/2022	Oʻahu	34492	21.275971	-157.575375	S06	Renee NV	Fishing
8/25/2022	Oʻahu	34496	21.275807	-157.556101	S19	Renee NV	Fishing
8/25/2022	Oʻahu	34013	21.262423	-157.575505	S19	Renee NV	Fishing
8/25/2022	Oʻahu	33835	21.258655	-157.667089	S01	Renee NV	Fishing
8/25/2022	Oʻahu	33679	21.254024	-157.652676	S22	Renee NV	Fishing
9/16/2022	Maui Nui	33040	21.224997	-157.002685	S20	Renee NV	Fishing
9/16/2022	Maui Nui	32541	21.211623	-157.017312	S11	Renee NV	Fishing
9/16/2022	Maui Nui	33327	21.234423	-157.036273	S24	Renee NV	Fishing
9/16/2022	Maui Nui	32378	21.207556	-157.055891	S08	Renee NV	Fishing
9/16/2022	Maui Nui	32702	21.216363	-157.036512	S07	Renee NV	Fishing
9/16/2022	Maui Nui	33022	21.226001	-157.089363	S05	Renee NV	Fishing
9/16/2022	Maui Nui	34689	21.276734	-157.185069	S24	Renee NV	Fishing
9/16/2022	Maui Nui	34955	21.286428	-157.247591	S20	Renee NV	Fishing
9/23/2022	Maui Nui	35632	21.323146	-157.304993	S24	Renee NV	Fishing
9/23/2022	Maui Nui	35357	21.305180	-157.314838	S22	Renee NV	Fishing
8/24/2022	Maui Nui	30041	21.098860	-156.672377	S22	Naomi K	Fishing
8/24/2022	Maui Nui	29032	21.076421	-156.682348	S19	Naomi K	Fishing
8/24/2022	Maui Nui	28258	21.062945	-156.687367	S19	Naomi K	Fishing
8/24/2022	Maui Nui	28259	21.062879	-156.682557	S16	Naomi K	Fishing
8/24/2022	Maui Nui	27695	21.053916	-156.687506	S18	Naomi K	Fishing
8/24/2022	Maui Nui	28263	21.062615	-156.663321	S19	Naomi K	Fishing
8/24/2022	Maui Nui	29507	21.085318	-156.672588	S18	Naomi K	Fishing
8/25/2022	Maui Nui	26512	21.034113	-156.562778	S05	Naomi K	Fishing
8/29/2022	Maui Nui	14174	20.674723	-156.693301	S20	Naomi K	Fishing
8/29/2022	Maui Nui	14185	20.674009	-156.640538	S15	Naomi K	Fishing
8/29/2022	Maui Nui	13703	20.656148	-156.655205	S21	Naomi K	Fishing
8/29/2022	Maui Nui	13323	20.643442	-156.717757	S22	Naomi K	Fishing
8/29/2022	Maui Nui	13812	20.661436	-156.712691	S22	Naomi K	Fishing
8/29/2022	Maui Nui	14050	20.670464	-156.712556	S22	Naomi K	Fishing
8/29/2022	Maui Nui	14292	20.679493	-156.712421	S19	Naomi K	Fishing
8/29/2022	Maui Nui	14293	20.679429	-156.707624	S22	Naomi K	Fishing
8/30/2022	Maui Nui	24506	20.999057	-156.332594	S13	Naomi K	Fishing
8/30/2022	Maui Nui	24215	20.995585	-156.399954	S08	Naomi K	Fishing

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8/30/2022	Maui Nui	23677	20.986705	-156.409722	S08	Naomi K	Fishing
8/30/2022	Maui Nui	24482	21.000826	-156.447937	S06	Naomi K	Fishing
8/30/2022	Maui Nui	23940	20.991364	-156.419255	S08	Naomi K	Fishing
8/30/2022	Maui Nui	26535	21.032491	-156.452206	S18	Naomi K	Fishing
8/30/2022	Maui Nui	28022	21.055773	-156.499903	S17	Naomi K	Fishing
8/30/2022	Maui Nui	26219	21.028621	-156.495548	S13	Naomi K	Fishing
9/4/2022	Maui Nui	12537	20.615844	-156.679802	S20	Naomi K	Fishing
9/4/2022	Maui Nui	12919	20.629644	-156.698778	S22	Naomi K	Fishing
9/4/2022	Maui Nui	12911	20.630151	-156.737141	S22	Naomi K	Fishing
9/4/2022	Maui Nui	12649	20.621185	-156.742070	S24	Naomi K	Fishing
9/4/2022	Maui Nui	12284	20.607766	-156.751859	S24	Naomi K	Fishing
9/4/2022	Maui Nui	12157	20.603746	-156.790284	S23	Naomi K	Fishing
9/4/2022	Maui Nui	13042	20.635164	-156.775440	S24	Naomi K	Fishing
9/9/2022	Maui Nui	11872	20.586080	-156.488466	S21	Naomi K	Fishing
9/9/2022	Maui Nui	11665	20.576983	-156.483821	S22	Naomi K	Fishing
9/9/2022	Maui Nui	11666	20.576913	-156.479028	S22	Naomi K	Fishing
9/9/2022	Maui Nui	11374	20.563442	-156.484043	S21	Naomi K	Fishing
9/9/2022	Maui Nui	11379	20.563092	-156.460081	S22	Naomi K	Fishing
9/9/2022	Maui Nui	11196	20.553924	-156.450646	S22	Naomi K	Fishing
9/9/2022	Maui Nui	11204	20.553355	-156.412310	S21	Naomi K	Fishing
9/10/2022	Maui Nui	21458	20.942745	-156.199052	S10	Naomi K	Fishing
9/10/2022	Maui Nui	22695	20.965149	-156.189023	S20	Naomi K	Fishing
9/10/2022	Maui Nui	23708	20.984373	-156.260757	S14	Naomi K	Fishing
9/10/2022	Maui Nui	24516	20.998296	-156.284538	S13	Naomi K	Fishing
9/10/2022	Maui Nui	26565	21.030268	-156.307998	S18	Naomi K	Fishing
9/10/2022	Maui Nui	28848	21.067276	-156.365044	S23	Naomi K	Fishing
9/11/2022	Maui Nui	26774	21.041530	-156.774268	S13	Naomi K	Fishing
9/11/2022	Maui Nui	26773	21.041593	-156.779077	S13	Naomi K	Fishing
9/11/2022	Maui Nui	22865	20.977694	-156.727141	S01	Naomi K	Fishing
9/11/2022	Maui Nui	22613	20.973244	-156.732015	S01	Naomi K	Fishing
9/11/2022	Maui Nui	20344	20.928481	-156.761525	S08	Naomi K	Fishing
9/11/2022	Maui Nui	22326	20.971063	-156.914732	S11	Naomi K	Fishing
9/11/2022	Maui Nui	21354	20.952589	-156.881338	S10	Naomi K	Fishing
9/11/2022	Maui Nui	22316	20.971644	-156.962801	S07	Naomi K	Fishing
9/14/2022	Maui Nui	19849	20.905287	-156.118088	S24	Naomi K	Fishing
9/14/2022	Maui Nui	17987	20.827189	-156.037965	S10	Naomi K	Fishing
9/14/2022	Maui Nui	16772	20.758085	-155.957743	S02	Naomi K	Fishing
9/14/2022	Maui Nui	13884	20.650811	-156.017423	S21	Naomi K	Fishing
9/14/2022	Maui Nui	13271	20.629155	-156.070584	S01	Naomi K	Fishing
9/14/2022	Maui Nui	12501	20.602808	-156.114232	S24	Naomi K	Fishing
9/14/2022	Maui Nui	10883	20.531637	-156.470186	S20	Naomi K	Fishing
9/14/2022	Maui Nui	10881	20.531776	-156.479769	S21	Naomi K	Fishing
9/15/2022	Maui Nui	10686	20.522604	-156.801038	S19	Naomi K	Fishing
9/15/2022	Maui Nui	10622	20.518028	-156.796310	S22	Naomi K	Fishing

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9/15/2022	Maui Nui	10314	20.490325	-156.748785	S20	Naomi K	Fishing
9/15/2022	Maui Nui	10561	20.513514	-156.796375	S22	Naomi K	Fishing
9/15/2022	Maui Nui	11076	20.554085	-156.790999	S20	Naomi K	Fishing
10/9/2022	Maui Nui	31215	21.171301	-157.484888	S21	Alice T	Fishing
10/9/2022	Maui Nui	31314	21.175468	-157.446323	S20	Alice T	Fishing
10/9/2022	Maui Nui	31228	21.170729	-157.422297	S20	Alice T	Fishing
10/9/2022	Maui Nui	31079	21.161562	-157.407949	S13	Alice T	Fishing
10/9/2022	Maui Nui	30401	21.126010	-157.470907	S01	Alice T	Fishing
10/9/2022	Maui Nui	30196	21.117321	-157.509505	S01	Alice T	Fishing
10/9/2022	Maui Nui	29944	21.109186	-157.615480	S15	Alice T	Fishing
10/9/2022	Maui Nui	27192	21.060041	-157.683302	S24	Alice T	Fishing
10/9/2022	Maui Nui	18273	20.865862	-157.689806	S14	Alice T	Fishing
10/9/2022	Maui Nui	18454	20.875257	-157.737786	S11	Alice T	Fishing
10/12/2022	Maui Nui	24354	21.011269	-157.279684	S22	Alice T	Fishing
10/12/2022	Maui Nui	23815	21.002527	-157.308641	S18	Alice T	Fishing
10/12/2022	Maui Nui	23290	20.993873	-157.347213	S12	Alice T	Fishing
10/12/2022	Maui Nui	24606	21.016868	-157.390250	S06	Alice T	Fishing
10/12/2022	Maui Nui	22281	20.976041	-157.371453	S12	Alice T	Fishing
9/3/2022	Big Island	3867	19.857079	-156.056408	S06	Ride On	Fishing
9/3/2022	Big Island	2861	19.776246	-156.081739	S05	Ride On	Fishing
9/3/2022	Big Island	3084	19.799428	-156.119469	S24	Ride On	Fishing
9/3/2022	Big Island	3137	19.803940	-156.119387	S24	Ride On	Fishing
9/3/2022	Big Island	3247	19.812734	-156.104920	S22	Ride On	Fishing
9/3/2022	Big Island	3544	19.834831	-156.075899	S06	Ride On	Fishing
9/9/2022	Big Island	231	18.939220	-155.698162	S22	Ride On	Fishing
9/9/2022	Big Island	247	18.943816	-155.702814	S16	Ride On	Fishing
9/9/2022	Big Island	739	19.137243	-155.926927	S22	Ride On	Fishing
9/9/2022	Big Island	958	19.213631	-155.906504	S22	Ride On	Fishing
9/9/2022	Big Island	1452	19.335214	-155.889954	S16	Ride On	Fishing
9/9/2022	Big Island	1547	19.371634	-155.908287	S21	Ride On	Fishing
9/17/2022	Big Island	9697	20.292629	-155.923884	S22	Ride On	Fishing
9/17/2022	Big Island	9694	20.292881	-155.938229	S24	Ride On	Fishing
9/17/2022	Big Island	9035	20.233810	-155.915480	S08	Ride On	Fishing
9/17/2022	Big Island	8639	20.188777	-155.921149	S10	Ride On	Fishing
9/17/2022	Big Island	7574	20.120934	-155.912923	S08	Ride On	Fishing
9/17/2022	Big Island	7342	20.102804	-155.908502	S14	Ride On	Fishing
9/17/2022	Big Island	6421	20.021174	-155.886226	S22	Ride On	Fishing
9/17/2022	Big Island	6481	20.025349	-155.867043	S21	Ride On	Fishing
9/17/2022	Big Island	6427	20.020668	-155.857586	S09	Ride On	Fishing
9/17/2022	Big Island	6311	20.011645	-155.857765	S12	Ride On	Fishing
9/17/2022	Big Island	6186	20.002875	-155.872263	S16	Ride On	Fishing
9/24/2022	Big Island	4212	19.879483	-156.046452	S15	Ride On	Fishing
9/24/2022	Big Island	4432	19.892060	-155.988959	S12	Ride On	Fishing
9/24/2022	Big Island	4502	19.896572	-155.988874	S12	Ride On	Fishing

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9/24/2022	Big Island	4646	19.905596	-155.988703	S12	Ride On	Fishing
9/24/2022	Big Island	4727	19.909376	-155.945683	S07	Ride On	Fishing
9/24/2022	Big Island	5243	19.941041	-155.949847	S12	Ride On	Fishing
9/24/2022	Big Island	5931	19.985332	-155.901254	S22	Ride On	Fishing
9/24/2022	Big Island	5996	19.989593	-155.886848	S22	Ride On	Fishing
9/24/2022	Big Island	6001	19.989172	-155.862986	S12	Ride On	Fishing
10/9/2022	Big Island	9712	20.291353	-155.852159	S07	Ride On	Fishing
10/9/2022	Big Island	9895	20.304368	-155.823194	S19	Ride On	Fishing
10/9/2022	Big Island	10070	20.318249	-155.842047	S22	Ride On	Fishing
10/9/2022	Big Island	10009	20.313910	-155.851702	S18	Ride On	Fishing
10/9/2022	Big Island	10066	20.318593	-155.861176	S21	Ride On	Fishing
10/9/2022	Big Island	10189	20.331955	-155.851337	S24	Ride On	Fishing
10/9/2022	Big Island	9945	20.309742	-155.870922	S18	Ride On	Fishing
10/9/2022	Big Island	9884	20.305316	-155.875795	S22	Ride On	Fishing
10/9/2022	Big Island	10116	20.323788	-155.899346	S24	Ride On	Fishing
10/9/2022	Big Island	9879	20.305742	-155.899705	S19	Ride On	Fishing
10/9/2022	Big Island	9816	20.301568	-155.918923	S22	Ride On	Fishing
10/14/2022	Big Island	7609	20.110750	-155.378108	S20	Ride On	Fishing
10/14/2022	Big Island	7611	20.110554	-155.368561	S17	Ride On	Fishing
10/14/2022	Big Island	7688	20.114072	-155.320721	S24	Ride On	Fishing
10/14/2022	Big Island	7380	20.091128	-155.302158	S17	Ride On	Fishing
10/14/2022	Big Island	7153	20.073591	-155.326443	S20	Ride On	Fishing
10/14/2022	Big Island	7258	20.083006	-155.345322	S20	Ride On	Fishing
10/14/2022	Big Island	7044	20.064871	-155.340969	S13	Ride On	Fishing
10/14/2022	Big Island	6946	20.055157	-155.307776	S13	Ride On	Fishing
10/14/2022	Big Island	7060	20.063271	-155.264620	S20	Ride On	Fishing
10/14/2022	Big Island	6960	20.053748	-155.240977	S20	Ride On	Fishing
10/14/2022	Big Island	6864	20.044119	-155.212567	S23	Ride On	Fishing
10/14/2022	Big Island	6464	20.006193	-155.127584	S24	Ride On	Fishing
10/15/2022	Big Island	4893	19.902093	-155.111053	S01	Ride On	Fishing
10/15/2022	Big Island	5274	19.924004	-155.081902	S20	Ride On	Fishing
10/15/2022	Big Island	5549	19.941929	-155.076690	S20	Ride On	Fishing
10/15/2022	Big Island	5776	19.954604	-155.038218	S24	Ride On	Fishing
10/15/2022	Big Island	5702	19.949990	-155.033564	S24	Ride On	Fishing
10/15/2022	Big Island	5636	19.944841	-155.005077	S24	Ride On	Fishing
10/15/2022	Big Island	4989	19.904595	-155.020394	S24	Ride On	Fishing
10/15/2022	Big Island	4531	19.878400	-155.059188	S20	Ride On	Fishing
10/29/2022	Big Island	2617	19.714217	-154.977510	S04	Ride On	Fishing
10/29/2022	Big Island	2631	19.718725	-154.977398	S04	Ride On	Fishing
10/29/2022	Big Island	2703	19.732140	-154.972299	S22	Ride On	Fishing
10/29/2022	Big Island	2978	19.764119	-154.990550	S12	Ride On	Fishing
10/29/2022	Big Island	3348	19.795456	-154.980235	S24	Ride On	Fishing
10/29/2022	Big Island	3850	19.830867	-154.950750	S24	Ride On	Fishing
10/29/2022	Big Island	4263	19.858665	-154.983409	S24	Ride On	Fishing

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
10/29/2022	Big Island	3917	19.836128	-154.983977	S24	Ride On	Fishing
10/29/2022	Big Island	3983	19.841064	-155.002917	S24	Ride On	Fishing
10/29/2022	Big Island	3984	19.840957	-154.998153	S24	Ride On	Fishing
10/30/2022	Big Island	3168	19.783422	-155.047239	S02	Ride On	Fishing
10/30/2022	Big Island	2973	19.764651	-155.014355	S02	Ride On	Fishing
10/30/2022	Big Island	3233	19.786976	-155.004270	S20	Ride On	Fishing
10/30/2022	Big Island	3909	19.836983	-155.022083	S20	Ride On	Fishing
10/30/2022	Big Island	3579	19.814340	-155.017882	S21	Ride On	Fishing
10/30/2022	Big Island	3908	19.837090	-155.026847	S20	Ride On	Fishing
10/30/2022	Big Island	3569	19.815397	-155.065511	S11	Ride On	Fishing
10/11/2022	Oʻahu	37836	21.589518	-157.818621	S21	Ebisui III	Fishing
10/11/2022	Oʻahu	37198	21.521350	-157.761248	S20	Ebisui III	Fishing
10/11/2022	Oʻahu	37114	21.507729	-157.751710	S20	Ebisui III	Fishing
10/11/2022	Oʻahu	36917	21.484964	-157.727774	S02	Ebisui III	Fishing
10/11/2022	Oʻahu	37036	21.498803	-157.766265	S02	Ebisui III	Fishing
10/11/2022	Oʻahu	37142	21.512424	-157.775804	S10	Ebisui III	Fishing
10/12/2022	Oʻahu	40083	21.753323	-158.001017	S12	Ebisui III	Fishing
10/12/2022	Oʻahu	40020	21.748836	-158.005883	S11	Ebisui III	Fishing
10/12/2022	Oʻahu	40207	21.762268	-157.986449	S22	Ebisui III	Fishing
10/12/2022	Oʻahu	40266	21.766815	-157.991253	S22	Ebisui III	Fishing
10/12/2022	Oʻahu	40481	21.785198	-158.044322	S24	Ebisui III	Fishing
10/12/2022	Oʻahu	39036	21.672781	-158.136883	S20	Ebisui III	Fishing
10/12/2022	Oʻahu	38688	21.641236	-158.151565	S17	Ebisui III	Fishing
10/12/2022	Oʻahu	38682	21.641382	-158.180554	S22	Ebisui III	Fishing
10/12/2022	Oʻahu	38730	21.645970	-158.195023	S24	Ebisui III	Fishing
10/17/2022	Maui Nui	25802	21.031520	-157.062994	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	25509	21.027168	-157.077480	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	25793	21.032007	-157.106278	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	26092	21.036576	-157.111031	S22	Ebisui III	Fishing
10/17/2022	Maui Nui	23571	20.995233	-157.049037	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	21805	20.963294	-157.020605	S07	Ebisui III	Fishing
10/17/2022	Maui Nui	21092	20.950026	-157.044816	S07	Ebisui III	Fishing
10/17/2022	Maui Nui	19471	20.910093	-157.107813	S21	Ebisui III	Fishing
10/17/2022	Maui Nui	18680	20.878325	-157.093796	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	17703	20.827894	-157.027184	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	17415	20.809833	-157.027419	S20	Ebisui III	Fishing
10/17/2022	Maui Nui	16680	20.773601	-157.018287	S20	Ebisui III	Fishing
10/18/2022	Oʻahu	38189	21.614577	-158.243504	S01	Ebisui III	Fishing
10/18/2022	Oʻahu	38360	21.623431	-158.204810	S21	Ebisui III	Fishing
10/18/2022	Oʻahu	38608	21.636889	-158.185411	S22	Ebisui III	Fishing
9/23/2022	Oʻahu	39239	21.690616	-158.093279	S08	Ebisui III	Fishing
9/23/2022	Oʻahu	39562	21.717770	-158.102777	S22	Ebisui III	Fishing
9/23/2022	Oʻahu	39623	21.722208	-158.088246	S21	Ebisui III	Fishing
9/23/2022	Oʻahu	39682	21.726644	-158.073716	S20	Ebisui III	Fishing

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
9/23/2022	Oʻahu	39874	21.740249	-158.083298	S22	Ebisui III	Fishing
9/23/2022	Oʻahu	40196	21.762586	-158.039637	S22	Ebisui III	Fishing
9/23/2022	Oʻahu	40136	21.758069	-158.039667	S22	Ebisui III	Fishing
9/23/2022	Oʻahu	40075	21.753552	-158.039697	S22	Ebisui III	Fishing
9/24/2022	Oʻahu	38345	21.623762	-158.277274	S21	Ebisui III	Fishing
9/24/2022	Oʻahu	38425	21.628300	-158.282082	S22	Ebisui III	Fishing
11/17/2022	Maui Nui	20655	20.945703	-157.511211	S24	Renee NV	Fishing
11/17/2022	Maui Nui	21058	20.954943	-157.535161	S14	Renee NV	Fishing
11/17/2022	Maui Nui	21773	20.967770	-157.453288	S11	Renee NV	Fishing
11/17/2022	Maui Nui	21306	20.958340	-157.410110	S24	Renee NV	Fishing
11/17/2022	Maui Nui	22769	20.985526	-157.419441	S15	Renee NV	Fishing
9/24/2022	Oʻahu	38506	21.632859	-158.291722	S22	Ebisui III	Fishing
9/24/2022	Oʻahu	38497	21.633038	-158.335204	S19	Ebisui III	Fishing
9/24/2022	Oʻahu	38329	21.624080	-158.354570	S22	Ebisui III	Fishing
9/24/2022	Oʻahu	38328	21.624099	-158.359401	S22	Ebisui III	Fishing
9/24/2022	Oʻahu	37624	21.583462	-158.364409	S22	Ebisui III	Fishing
10/9/2022	Maui Nui	27304	21.055009	-157.144474	S11	Renee NV	Fishing
10/9/2022	Maui Nui	25786	21.032379	-157.139944	S24	Renee NV	Fishing
10/9/2022	Maui Nui	26396	21.041198	-157.120593	S17	Renee NV	Fishing
10/9/2022	Maui Nui	25213	21.023084	-157.116010	S22	Renee NV	Fishing
10/9/2022	Maui Nui	25214	21.023030	-157.111201	S22	Renee NV	Fishing
10/9/2022	Maui Nui	24929	21.018515	-157.111258	S22	Renee NV	Fishing
10/9/2022	Maui Nui	23823	21.000346	-157.101869	S22	Renee NV	Fishing
9/24/2022	Oʻahu	37496	21.569855	-158.349981	S24	Ebisui III	Fishing
10/9/2022	Maui Nui	23561	20.995777	-157.097118	S22	Renee NV	Fishing
9/23/2022	Maui Nui	35277	21.300616	-157.310071	S19	Renee NV	Fishing
9/23/2022	Maui Nui	34348	21.269102	-157.320067	S19	Renee NV	Fishing
9/23/2022	Maui Nui	34185	21.264682	-157.329754	S20	Renee NV	Fishing
9/23/2022	Maui Nui	33865	21.255651	-157.329856	S20	Renee NV	Fishing
9/23/2022	Maui Nui	32984	21.227974	-157.272366	S01	Renee NV	Fishing
9/23/2022	Maui Nui	32050	21.200979	-157.282312	S01	Renee NV	Fishing
10/2/2022	Oʻahu	33360	21.246287	-157.826197	S11	Renee NV	Fishing
10/2/2022	Oʻahu	33486	21.250970	-157.850251	S24	Renee NV	Fishing
10/2/2022	Oʻahu	32167	21.211493	-158.038428	S24	Renee NV	Fishing
10/2/2022	Oʻahu	33350	21.247462	-158.009284	S23	Renee NV	Fishing
10/2/2022	Oʻahu	33479	21.251951	-158.004435	S23	Renee NV	Fishing
10/11/2022	Oʻahu	38817	21.648668	-157.880950	S07	Ebisui III	Fishing
10/11/2022	Oʻahu	40165	21.757196	-157.899451	S24	Ebisui III	Fishing
10/11/2022	Oʻahu	39377	21.698252	-157.866068	S20	Ebisui III	Fishing
10/11/2022	Oʻahu	39264	21.689447	-157.899966	S01	Ebisui III	Fishing
9/9/2022	Kauaʻi	45357	22.261469	-159.511522	S07	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45394	22.265986	-159.511539	S13	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45427	22.270503	-159.511555	S17	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45457	22.275035	-159.506718	S17	Yukie Lynn	Fishing

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
9/9/2022	Kauaʻi	45486	22.279582	-159.497028	S23	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45264	22.252783	-159.385325	S11	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45207	22.248343	-159.351346	S22	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45208	22.248353	-159.346494	S22	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	45076	22.239359	-159.327063	S23	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	44359	22.176202	-159.283267	S02	Yukie Lynn	Fishing
9/9/2022	Kauaʻi	44241	22.162675	-159.268692	S21	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	44204	22.158158	-159.268683	S12	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	43957	22.122021	-159.268615	S20	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	43742	22.085867	-159.278240	S03	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	43458	22.040661	-159.297533	S20	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	41927	21.905039	-159.350498	S20	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	41303	21.868779	-159.403644	S02	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	41158	21.859779	-159.389101	S22	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	41026	21.850636	-159.432626	S24	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	41025	21.850624	-159.437465	S22	Yukie Lynn	Fishing
9/10/2022	Kauaʻi	41145	21.859619	-159.452009	S03	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	44285	22.170028	-159.787616	S12	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	43963	22.124741	-159.811603	S05	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	43962	22.124717	-159.816451	S21	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	43880	22.111143	-159.821220	S21	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	43138	22.007305	-159.810933	S14	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	42822	21.975758	-159.796225	S24	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	42381	21.944411	-159.737949	S24	Yukie Lynn	Fishing
10/8/2022	Kauaʻi	41356	21.872777	-159.577879	S16	Yukie Lynn	Fishing
11/17/2022	Niʻihau	40342	21.774093	-160.264178	S24	Yukie Lynn	Fishing
11/17/2022	Niʻihau	40907	21.837284	-160.269571	S07	Yukie Lynn	Fishing
11/17/2022	Niʻihau	41230	21.864418	-160.264972	S22	Yukie Lynn	Fishing
11/17/2022	Niʻihau	41814	21.896106	-160.255572	S01	Yukie Lynn	Fishing
11/17/2022	Niʻihau	42181	21.927793	-160.246168	S21	Yukie Lynn	Fishing
11/17/2022	Niʻihau	42348	21.941379	-160.241446	S22	Yukie Lynn	Fishing
11/17/2022	Niʻihau	42415	21.946004	-160.226962	S17	Yukie Lynn	Fishing
11/17/2022	Niʻihau	42794	21.973316	-160.198142	S17	Yukie Lynn	Fishing
11/17/2022	Niʻihau	43164	22.009928	-160.130640	S20	Yukie Lynn	Fishing
11/17/2022	Niʻihau	43573	22.055258	-160.106774	S24	Yukie Lynn	Fishing
11/30/2022	Niʻihau	40655	21.802495	-160.080637	S22	Yukie Lynn	Fishing
11/30/2022	Niʻihau	40709	21.810970	-160.162929	S14	Yukie Lynn	Fishing
11/30/2022	Niʻihau	40823	21.824820	-160.119504	S21	Yukie Lynn	Fishing
11/30/2022	Niʻihau	40904	21.834237	-160.061525	S24	Yukie Lynn	Fishing
11/30/2022	Niʻihau	40967	21.843113	-160.085781	S20	Yukie Lynn	Fishing
11/30/2022	Niʻihau	42151	21.924599	-160.057353	S01	Yukie Lynn	Fishing
11/30/2022	Niʻihau	40800	21.820656	-160.066262	S22	Yukie Lynn	Fishing
9/3/2022	Maui Nui	11532	20.576039	-156.742735	S19	Naomi K	Fishing
9/3/2022	Maui Nui	11627	20.580616	-156.747463	S19	Naomi K	Fishing

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
9/3/2022	Maui Nui	11830	20.589646	-156.747330	S24	Naomi K	Fishing
9/3/2022	Maui Nui	11727	20.585069	-156.742602	S22	Naomi K	Fishing
9/3/2022	Maui Nui	11832	20.589520	-156.737741	S19	Naomi K	Fishing
9/3/2022	Maui Nui	12054	20.598487	-156.732814	S22	Naomi K	Fishing
9/3/2022	Maui Nui	11834	20.589395	-156.728153	S21	Naomi K	Fishing
9/3/2022	Maui Nui	11945	20.593592	-156.704115	S22	Naomi K	Fishing
9/3/2022	Maui Nui	12179	20.602365	-156.684801	S15	Naomi K	Fishing

Appendix 3. Primary sampling units (PSU) sampled by camera gear during the 2021 BFISH with location, stratum, and vessel.

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
07/31/2022	Big Island	1714	19.4441505	-155.9259465	S10	Ao Shibi IV	Camera
07/31/2022	Big Island	1714	19.4441505	-155.9259465	S10	Ao Shibi IV	Camera
07/31/2022	Big Island	1734	19.4533358	-155.9352899	S16	Ao Shibi IV	Camera
07/31/2022	Big Island	1734	19.4533358	-155.9352899	S16	Ao Shibi IV	Camera
07/31/2022	Big Island	1882	19.5082818	-155.9818553	S11	Ao Shibi IV	Camera
07/31/2022	Big Island	1882	19.5082818	-155.9818553	S11	Ao Shibi IV	Camera
07/31/2022	Big Island	2299	19.6263151	-156.0225283	S05	Ao Shibi IV	Camera
07/31/2022	Big Island	2299	19.6263151	-156.0225283	S05	Ao Shibi IV	Camera
07/31/2022	Big Island	2539	19.7035766	-156.0544627	S02	Ao Shibi IV	Camera
07/31/2022	Big Island	2539	19.7035766	-156.0544627	S02	Ao Shibi IV	Camera
07/31/2022	Big Island	2780	19.7673757	-156.0914363	S08	Ao Shibi IV	Camera
07/31/2022	Big Island	2780	19.7673757	-156.0914363	S08	Ao Shibi IV	Camera
07/31/2022	Big Island	2901	19.7809135	-156.0911904	S07	Ao Shibi IV	Camera
07/31/2022	Big Island	2901	19.7809135	-156.0911904	S07	Ao Shibi IV	Camera
08/01/2022	Big Island	3732	19.848368	-156.0756509	S08	Ao Shibi IV	Camera
08/01/2022	Big Island	3732	19.848368	-156.0756509	S08	Ao Shibi IV	Camera
08/01/2022	Big Island	4007	19.8660247	-156.0514721	S05	Ao Shibi IV	Camera
08/01/2022	Big Island	4007	19.8660247	-156.0514721	S05	Ao Shibi IV	Camera
08/01/2022	Big Island	3869	19.8569209	-156.0468698	S08	Ao Shibi IV	Camera
08/01/2022	Big Island	3869	19.8569209	-156.0468698	S08	Ao Shibi IV	Camera
08/01/2022	Big Island	3871	19.8567625	-156.0373315	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	3871	19.8567625	-156.0373315	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	4012	19.8656282	-156.027625	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	4012	19.8656282	-156.027625	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	4082	19.8701405	-156.0275408	S11	Ao Shibi IV	Camera
08/01/2022	Big Island	4082	19.8701405	-156.0275408	S11	Ao Shibi IV	Camera
08/01/2022	Big Island	4155	19.8741725	-155.9988391	S05	Ao Shibi IV	Camera
08/01/2022	Big Island	4155	19.8741725	-155.9988391	S05	Ao Shibi IV	Camera
08/01/2022	Big Island	4430	19.8922212	-155.9984989	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	4430	19.8922212	-155.9984989	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	4574	19.9010034	-155.9840178	S11	Ao Shibi IV	Camera
08/01/2022	Big Island	4574	19.9010034	-155.9840178	S11	Ao Shibi IV	Camera
08/01/2022	Big Island	4795	19.9143774	-155.9742198	S11	Ao Shibi IV	Camera
08/01/2022	Big Island	4795	19.9143774	-155.9742198	S11	Ao Shibi IV	Camera
08/01/2022	Big Island	5025	19.9275874	-155.9548782	S08	Ao Shibi IV	Camera
08/01/2022	Big Island	5025	19.9275874	-155.9548782	S08	Ao Shibi IV	Camera
08/01/2022	Big Island	4952	19.9229116	-155.9454232	S09	Ao Shibi IV	Camera
08/01/2022	Big Island	4952	19.9229116	-155.9454232	S09	Ao Shibi IV	Camera
08/01/2022	Big Island	4435	19.8918171	-155.974649	S12	Ao Shibi IV	Camera

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
08/01/2022	Big Island	4435	19.8918171	-155.974649	S12	Ao Shibi IV	Camera
08/01/2022	Big Island	4161	19.8736877	-155.9702225	S01	Ao Shibi IV	Camera
08/01/2022	Big Island	4161	19.8736877	-155.9702225	S01	Ao Shibi IV	Camera
08/02/2022	Big Island	5658	19.9674519	-155.9111505	S12	Ao Shibi IV	Camera
08/02/2022	Big Island	5658	19.9674519	-155.9111505	S12	Ao Shibi IV	Camera
08/02/2022	Big Island	6312	20.01156	-155.8529924	S11	Ao Shibi IV	Camera
08/02/2022	Big Island	6312	20.01156	-155.8529924	S11	Ao Shibi IV	Camera
08/02/2022	Big Island	8997	20.2294658	-155.9251291	S10	Ao Shibi IV	Camera
08/02/2022	Big Island	8997	20.2294658	-155.9251291	S10	Ao Shibi IV	Camera
08/02/2022	Big Island	9769	20.2960364	-155.8616308	S14	Ao Shibi IV	Camera
08/02/2022	Big Island	9769	20.2960364	-155.8616308	S14	Ao Shibi IV	Camera
08/02/2022	Big Island	9715	20.2910945	-155.8378143	S10	Ao Shibi IV	Camera
08/02/2022	Big Island	9715	20.2910945	-155.8378143	S10	Ao Shibi IV	Camera
08/02/2022	Big Island	9536	20.2772141	-155.8189653	S01	Ao Shibi IV	Camera
08/02/2022	Big Island	9536	20.2772141	-155.8189653	S01	Ao Shibi IV	Camera
08/03/2022	Big Island	9259	20.2531639	-155.7381655	S07	Ao Shibi IV	Camera
08/03/2022	Big Island	9259	20.2531639	-155.7381655	S07	Ao Shibi IV	Camera
08/03/2022	Big Island	9166	20.2441422	-155.738354	S02	Ao Shibi IV	Camera
08/03/2022	Big Island	9166	20.2441422	-155.738354	S02	Ao Shibi IV	Camera
08/03/2022	Big Island	9049	20.230074	-155.7099626	S10	Ao Shibi IV	Camera
08/03/2022	Big Island	9049	20.230074	-155.7099626	S10	Ao Shibi IV	Camera
08/03/2022	Big Island	9014	20.2252036	-155.6909425	S15	Ao Shibi IV	Camera
08/03/2022	Big Island	9014	20.2252036	-155.6909425	S15	Ao Shibi IV	Camera
08/04/2022	Maui Nui	12378	20.5989318	-156.1526544	S10	Ao Shibi IV	Camera
08/04/2022	Maui Nui	12378	20.5989318	-156.1526544	S10	Ao Shibi IV	Camera
08/04/2022	Maui Nui	12380	20.5987736	-156.1430698	S10	Ao Shibi IV	Camera
08/04/2022	Maui Nui	12380	20.5987736	-156.1430698	S10	Ao Shibi IV	Camera
08/04/2022	Maui Nui	13274	20.6289103	-156.0562051	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	13274	20.6289103	-156.0562051	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	17829	20.8179986	-156.0285437	S11	Ao Shibi IV	Camera
08/04/2022	Maui Nui	17829	20.8179986	-156.0285437	S11	Ao Shibi IV	Camera
08/04/2022	Maui Nui	18253	20.8413022	-156.0712963	S02	Ao Shibi IV	Camera
08/04/2022	Maui Nui	18253	20.8413022	-156.0712963	S02	Ao Shibi IV	Camera
08/04/2022	Maui Nui	19175	20.8827262	-156.1185193	S02	Ao Shibi IV	Camera
08/04/2022	Maui Nui	19175	20.8827262	-156.1185193	S02	Ao Shibi IV	Camera
08/04/2022	Maui Nui	19840	20.9060109	-156.1613058	S10	Ao Shibi IV	Camera
08/04/2022	Maui Nui	19840	20.9060109	-156.1613058	S10	Ao Shibi IV	Camera
08/04/2022	Maui Nui	20005	20.9108415	-156.1804298	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	20005	20.9108415	-156.1804298	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	20194	20.9155123	-156.1899503	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	20194	20.9155123	-156.1899503	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	21453	20.9431377	-156.2230689	S03	Ao Shibi IV	Camera

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
08/04/2022	Maui Nui	21453	20.9431377	-156.2230689	S03	Ao Shibi IV	Camera
08/04/2022	Maui Nui	22183	20.9569873	-156.2420348	S07	Ao Shibi IV	Camera
08/04/2022	Maui Nui	22183	20.9569873	-156.2420348	S07	Ao Shibi IV	Camera
08/05/2022	Maui Nui	19962	20.9194525	-156.7616594	S08	Ao Shibi IV	Camera
08/05/2022	Maui Nui	19962	20.9194525	-156.7616594	S08	Ao Shibi IV	Camera
08/05/2022	Maui Nui	21153	20.9464124	-156.7516457	S12	Ao Shibi IV	Camera
08/05/2022	Maui Nui	21153	20.9464124	-156.7516457	S12	Ao Shibi IV	Camera
08/05/2022	Maui Nui	28771	21.0726214	-156.7353213	S05	Ao Shibi IV	Camera
08/05/2022	Maui Nui	28771	21.0726214	-156.7353213	S05	Ao Shibi IV	Camera
08/05/2022	Maui Nui	29261	21.081714	-156.7399944	S01	Ao Shibi IV	Camera
08/05/2022	Maui Nui	29261	21.081714	-156.7399944	S01	Ao Shibi IV	Camera
08/05/2022	Maui Nui	28248	21.0635929	-156.7354581	S20	Ao Shibi IV	Camera
08/05/2022	Maui Nui	28248	21.0635929	-156.7354581	S20	Ao Shibi IV	Camera
08/05/2022	Maui Nui	29500	21.0857763	-156.7062566	S13	Ao Shibi IV	Camera
08/05/2022	Maui Nui	29500	21.0857763	-156.7062566	S13	Ao Shibi IV	Camera
08/05/2022	Maui Nui	24195	20.9970264	-156.4960754	S06	Ao Shibi IV	Camera
08/05/2022	Maui Nui	24195	20.9970264	-156.4960754	S06	Ao Shibi IV	Camera
08/05/2022	Maui Nui	23407	20.9827724	-156.4482438	S09	Ao Shibi IV	Camera
08/05/2022	Maui Nui	23407	20.9827724	-156.4482438	S09	Ao Shibi IV	Camera
08/05/2022	Maui Nui	22429	20.9619641	-156.2707773	S01	Ao Shibi IV	Camera
08/05/2022	Maui Nui	22429	20.9619641	-156.2707773	S01	Ao Shibi IV	Camera
08/06/2022	Maui Nui	30449	21.1171135	-156.6865276	S06	Ao Shibi IV	Camera
08/06/2022	Maui Nui	30449	21.1171135	-156.6865276	S06	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32592	21.2081764	-156.7428894	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32592	21.2081764	-156.7428894	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32272	21.2001599	-156.8200473	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32272	21.2001599	-156.8200473	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32119	21.1958929	-156.8393688	S07	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32119	21.1958929	-156.8393688	S07	Ao Shibi IV	Camera
08/06/2022	Maui Nui	31836	21.187109	-156.8587545	S04	Ao Shibi IV	Camera
08/06/2022	Maui Nui	31836	21.187109	-156.8587545	S04	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32382	21.2073327	-157.0366317	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32382	21.2073327	-157.0366317	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32861	21.2212667	-157.0701597	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	32861	21.2212667	-157.0701597	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	33305	21.2356762	-157.1470385	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	33305	21.2356762	-157.1470385	S05	Ao Shibi IV	Camera
08/06/2022	Maui Nui	33416	21.2413226	-157.252942	S01	Ao Shibi IV	Camera
08/06/2022	Maui Nui	33416	21.2413226	-157.252942	S01	Ao Shibi IV	Camera
08/07/2022	Maui Nui	34200	21.2639503	-157.257493	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	34200	21.2639503	-157.257493	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	32651	21.2192846	-157.3061825	S05	Ao Shibi IV	Camera

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
08/07/2022	Maui Nui	32651	21.2192846	-157.3061825	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31161	21.1658032	-157.3790144	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31161	21.1658032	-157.3790144	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31142	21.1666553	-157.4704901	S13	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31142	21.1666553	-157.4704901	S13	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31210	21.1715154	-157.5089622	S16	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31210	21.1715154	-157.5089622	S16	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31058	21.162483	-157.5090527	S15	Ao Shibi IV	Camera
08/07/2022	Maui Nui	31058	21.162483	-157.5090527	S15	Ao Shibi IV	Camera
08/07/2022	Maui Nui	30748	21.1442045	-157.4851638	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	30748	21.1442045	-157.4851638	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	30736	21.1447116	-157.5429318	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	30736	21.1447116	-157.5429318	S05	Ao Shibi IV	Camera
08/07/2022	Maui Nui	26279	21.0465655	-157.6930434	S10	Ao Shibi IV	Camera
08/07/2022	Maui Nui	26279	21.0465655	-157.6930434	S10	Ao Shibi IV	Camera
08/25/2022	Big Island	8028	20.1410726	-155.5398317	S14	Ao Shibi IV	Camera
08/25/2022	Big Island	8028	20.1410726	-155.5398317	S14	Ao Shibi IV	Camera
08/25/2022	Big Island	8029	20.1409787	-155.5350564	S20	Ao Shibi IV	Camera
08/25/2022	Big Island	8029	20.1409787	-155.5350564	S20	Ao Shibi IV	Camera
08/25/2022	Big Island	7804	20.1265979	-155.4923815	S14	Ao Shibi IV	Camera
08/25/2022	Big Island	7804	20.1265979	-155.4923815	S14	Ao Shibi IV	Camera
08/25/2022	Big Island	7588	20.1127828	-155.4783607	S02	Ao Shibi IV	Camera
08/25/2022	Big Island	7588	20.1127828	-155.4783607	S02	Ao Shibi IV	Camera
08/26/2022	Big Island	7248	20.0839883	-155.3930498	S07	Ao Shibi IV	Camera
08/26/2022	Big Island	7248	20.0839883	-155.3930498	S07	Ao Shibi IV	Camera
08/26/2022	Big Island	6793	20.0418296	-155.3176354	S02	Ao Shibi IV	Camera
08/26/2022	Big Island	6793	20.0418296	-155.3176354	S02	Ao Shibi IV	Camera
08/26/2022	Big Island	6748	20.036922	-155.2986566	S10	Ao Shibi IV	Camera
08/26/2022	Big Island	6748	20.036922	-155.2986566	S10	Ao Shibi IV	Camera
08/26/2022	Big Island	6800	20.0411303	-155.2842376	S15	Ao Shibi IV	Camera
08/26/2022	Big Island	6800	20.0411303	-155.2842376	S15	Ao Shibi IV	Camera
08/26/2022	Big Island	6751	20.0366216	-155.2843438	S07	Ao Shibi IV	Camera
08/26/2022	Big Island	6751	20.0366216	-155.2843438	S07	Ao Shibi IV	Camera
08/26/2022	Big Island	6322	19.9994421	-155.2327261	S05	Ao Shibi IV	Camera
08/26/2022	Big Island	6322	19.9994421	-155.2327261	S05	Ao Shibi IV	Camera
08/26/2022	Big Island	4971	19.9064965	-155.1061762	S10	Ao Shibi IV	Camera
08/26/2022	Big Island	4971	19.9064965	-155.1061762	S10	Ao Shibi IV	Camera
08/26/2022	Big Island	5043	19.9113173	-155.1203642	S02	Ao Shibi IV	Camera
08/26/2022	Big Island	5043	19.9113173	-155.1203642	S02	Ao Shibi IV	Camera
08/27/2022	Big Island	4245	19.8605795	-155.0691632	S10	Ao Shibi IV	Camera
08/27/2022	Big Island	4245	19.8605795	-155.0691632	S10	Ao Shibi IV	Camera
08/27/2022	Big Island	3759	19.828815	-155.0604141	S10	Ao Shibi IV	Camera

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
08/27/2022	Big Island	3759	19.828815	-155.0604141	S10	Ao Shibi IV	Camera
08/27/2022	Big Island	5268	19.9246326	-155.1105007	S14	Ao Shibi IV	Camera
08/27/2022	Big Island	5268	19.9246326	-155.1105007	S14	Ao Shibi IV	Camera
08/27/2022	Big Island	2673	19.7278462	-154.9819315	S03	Ao Shibi IV	Camera
08/27/2022	Big Island	2673	19.7278462	-154.9819315	S03	Ao Shibi IV	Camera
08/27/2022	Big Island	2587	19.7005886	-154.9730899	S11	Ao Shibi IV	Camera
08/27/2022	Big Island	2587	19.7005886	-154.9730899	S11	Ao Shibi IV	Camera
08/27/2022	Big Island	2429	19.641459	-154.9507691	S10	Ao Shibi IV	Camera
08/27/2022	Big Island	2429	19.641459	-154.9507691	S10	Ao Shibi IV	Camera
08/27/2022	Big Island	2328	19.6094794	-154.9325359	S03	Ao Shibi IV	Camera
08/27/2022	Big Island	2328	19.6094794	-154.9325359	S03	Ao Shibi IV	Camera
08/28/2022	Big Island	1564	19.3575006	-154.9578389	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1564	19.3575006	-154.9578389	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1543	19.3486966	-154.9675587	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1543	19.3486966	-154.9675587	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1509	19.3356988	-154.9916335	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1509	19.3356988	-154.9916335	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1387	19.2927867	-155.0924322	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1387	19.2927867	-155.0924322	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1357	19.2796679	-155.1117437	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1357	19.2796679	-155.1117437	S16	Ao Shibi IV	Camera
08/28/2022	Big Island	1206	19.2541199	-155.183588	S11	Ao Shibi IV	Camera
08/28/2022	Big Island	1206	19.2541199	-155.183588	S11	Ao Shibi IV	Camera
08/29/2022	Big Island	1221	19.2607814	-155.2879331	S12	Ao Shibi IV	Camera
08/29/2022	Big Island	1221	19.2607814	-155.2879331	S12	Ao Shibi IV	Camera
08/29/2022	Big Island	1014	19.2256648	-155.3362165	S16	Ao Shibi IV	Camera
08/29/2022	Big Island	1014	19.2256648	-155.3362165	S16	Ao Shibi IV	Camera
08/29/2022	Big Island	954	19.1991755	-155.3652961	S12	Ao Shibi IV	Camera
08/29/2022	Big Island	954	19.1991755	-155.3652961	S12	Ao Shibi IV	Camera
08/30/2022	Big Island	79	18.8889176	-155.6612213	S10	Ao Shibi IV	Camera
08/30/2022	Big Island	79	18.8889176	-155.6612213	S10	Ao Shibi IV	Camera
08/30/2022	Big Island	306	18.9622821	-155.7261677	S16	Ao Shibi IV	Camera
08/30/2022	Big Island	306	18.9622821	-155.7261677	S16	Ao Shibi IV	Camera
08/30/2022	Big Island	323	18.9669611	-155.7355634	S16	Ao Shibi IV	Camera
08/30/2022	Big Island	323	18.9669611	-155.7355634	S16	Ao Shibi IV	Camera
09/12/2022	Maui Nui	16646	20.7631501	-156.5575519	S01	Rubber Duck	Camera
09/12/2022	Maui Nui	16646	20.7631501	-156.5575519	S01	Rubber Duck	Camera
09/12/2022	Maui Nui	15097	20.7041969	-156.539305	S07	Rubber Duck	Camera
09/12/2022	Maui Nui	15097	20.7041969	-156.539305	S07	Rubber Duck	Camera
09/12/2022	Maui Nui	15854	20.73302	-156.6636215	S14	Rubber Duck	Camera
09/12/2022	Maui Nui	15854	20.73302	-156.6636215	S14	Rubber Duck	Camera
09/12/2022	Maui Nui	15980	20.7376644	-156.6731495	S11	Rubber Duck	Camera

SAMPLE_DATE	Island	PSU	Latitude	Longitude	Strata	VESSEL	Gear
09/12/2022	Maui Nui	15980	20.7376644	-156.6731495	S11	Rubber Duck	Camera
09/12/2022	Maui Nui	15881	20.7312109	-156.5340693	S01	Steel Toe	Camera
09/12/2022	Maui Nui	15881	20.7312109	-156.5340693	S01	Steel Toe	Camera
09/12/2022	Maui Nui	15095	20.7043338	-156.5488993	S07	Steel Toe	Camera
09/12/2022	Maui Nui	15095	20.7043338	-156.5488993	S07	Steel Toe	Camera
09/12/2022	Maui Nui	14192	20.6735457	-156.6069626	S14	Steel Toe	Camera
09/12/2022	Maui Nui	14192	20.6735457	-156.6069626	S14	Steel Toe	Camera
09/12/2022	Maui Nui	15975	20.7379875	-156.6971431	S11	Steel Toe	Camera
09/12/2022	Maui Nui	15975	20.7379875	-156.6971431	S11	Steel Toe	Camera
09/12/2022	Maui Nui	15872	20.7318247	-156.5772519	S10	Sette	Camera
09/12/2022	Maui Nui	15872	20.7318247	-156.5772519	S10	Sette	Camera
09/12/2022	Maui Nui	15728	20.728244	-156.6444976	S13	Sette	Camera
09/12/2022	Maui Nui	15728	20.728244	-156.6444976	S13	Sette	Camera
09/13/2022	Maui Nui	12576	20.6132313	-156.4928166	S07	Rubber Duck	Camera
09/13/2022	Maui Nui	12576	20.6132313	-156.4928166	S07	Rubber Duck	Camera
09/13/2022	Maui Nui	12335	20.604412	-156.507346	S13	Rubber Duck	Camera
09/13/2022	Maui Nui	12335	20.604412	-156.507346	S13	Rubber Duck	Camera
09/13/2022	Maui Nui	12796	20.6245488	-156.6556895	S11	Rubber Duck	Camera
09/13/2022	Maui Nui	12796	20.6245488	-156.6556895	S11	Rubber Duck	Camera
09/13/2022	Maui Nui	10955	20.5444377	-156.7431994	S07	Rubber Duck	Camera
09/13/2022	Maui Nui	10955	20.5444377	-156.7431994	S07	Rubber Duck	Camera
09/13/2022	Maui Nui	10899	20.5402336	-156.7672294	S05	Rubber Duck	Camera
09/13/2022	Maui Nui	10899	20.5402336	-156.7672294	S05	Rubber Duck	Camera
09/13/2022	Maui Nui	11672	20.5764914	-156.4502711	S16	Steel Toe	Camera
09/13/2022	Maui Nui	11672	20.5764914	-156.4502711	S16	Steel Toe	Camera
09/13/2022	Maui Nui	12334	20.6044811	-156.5121399	S09	Steel Toe	Camera
09/13/2022	Maui Nui	12334	20.6044811	-156.5121399	S09	Steel Toe	Camera
09/13/2022	Maui Nui	13076	20.6329857	-156.6123939	S14	Steel Toe	Camera
09/13/2022	Maui Nui	13076	20.6329857	-156.6123939	S14	Steel Toe	Camera
09/13/2022	Maui Nui	11161	20.5579188	-156.7382072	S10	Steel Toe	Camera
09/13/2022	Maui Nui	11161	20.5579188	-156.7382072	S10	Steel Toe	Camera
09/13/2022	Maui Nui	13213	20.6376322	-156.6219141	S15	Sette	Camera
09/13/2022	Maui Nui	13213	20.6376322	-156.6219141	S15	Sette	Camera
09/14/2022	Maui Nui	16818	20.7739079	-156.6821962	S03	Rubber Duck	Camera
09/14/2022	Maui Nui	16818	20.7739079	-156.6821962	S03	Rubber Duck	Camera
09/14/2022	Maui Nui	16512	20.7609427	-156.7255983	S11	Rubber Duck	Camera
09/14/2022	Maui Nui	16512	20.7609427	-156.7255983	S11	Rubber Duck	Camera
09/14/2022	Maui Nui	16068	20.7439452	-156.8074541	S08	Rubber Duck	Camera
09/14/2022	Maui Nui	16068	20.7439452	-156.8074541	S08	Rubber Duck	Camera
09/14/2022	Maui Nui	14891	20.7045085	-156.9040032	S22	Rubber Duck	Camera
09/14/2022	Maui Nui	14891	20.7045085	-156.9040032	S22	Rubber Duck	Camera
09/14/2022	Maui Nui	17203	20.7918348	-156.6723197	S01	Steel Toe	Camera

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09/14/2022	Maui Nui	17203	20.7918348	-156.6723197	S01	Steel Toe	Camera
09/14/2022	Maui Nui	15844	20.7336654	-156.7116073	S10	Steel Toe	Camera
09/14/2022	Maui Nui	15844	20.7336654	-156.7116073	S10	Steel Toe	Camera
09/14/2022	Maui Nui	15557	20.7263115	-156.8413059	S17	Steel Toe	Camera
09/14/2022	Maui Nui	15557	20.7263115	-156.8413059	S17	Steel Toe	Camera
09/14/2022	Maui Nui	16063	20.7442497	-156.8314509	S10	Steel Toe	Camera
09/14/2022	Maui Nui	16063	20.7442497	-156.8314509	S10	Steel Toe	Camera
09/14/2022	Maui Nui	15656	20.7326295	-156.990019	S14	Steel Toe	Camera
09/14/2022	Maui Nui	15656	20.7326295	-156.990019	S14	Steel Toe	Camera
09/14/2022	Maui Nui	16900	20.7795672	-156.7685299	S02	Sette	Camera
09/14/2022	Maui Nui	16900	20.7795672	-156.7685299	S02	Sette	Camera
09/15/2022	Oʻahu	35703	21.3350845	-157.623012	S11	Rubber Duck	Camera
09/15/2022	Oʻahu	35703	21.3350845	-157.623012	S11	Rubber Duck	Camera
09/15/2022	Oʻahu	35259	21.3030689	-157.5751134	S02	Rubber Duck	Camera
09/15/2022	Oʻahu	35259	21.3030689	-157.5751134	S02	Rubber Duck	Camera
09/15/2022	Oʻahu	34645	21.2804468	-157.5705125	S06	Rubber Duck	Camera
09/15/2022	Oʻahu	34645	21.2804468	-157.5705125	S06	Rubber Duck	Camera
09/15/2022	Oʻahu	34494	21.2758895	-157.5657377	S13	Rubber Duck	Camera
09/15/2022	Oʻahu	34494	21.2758895	-157.5657377	S13	Rubber Duck	Camera
09/15/2022	Oʻahu	33639	21.2554538	-157.845398	S15	Steel Toe	Camera
09/15/2022	Oʻahu	33639	21.2554538	-157.845398	S15	Steel Toe	Camera
09/15/2022	Oʻahu	33119	21.236483	-157.7202828	S09	Steel Toe	Camera
09/15/2022	Oʻahu	33119	21.236483	-157.7202828	S09	Steel Toe	Camera
09/15/2022	Oʻahu	33834	21.258693	-157.6719069	S04	Steel Toe	Camera
09/15/2022	Oʻahu	33834	21.258693	-157.6719069	S04	Steel Toe	Camera
09/15/2022	Oʻahu	35943	21.3624173	-157.6516869	S10	Sette	Camera
09/15/2022	Oʻahu	35943	21.3624173	-157.6516869	S10	Sette	Camera
09/16/2022	Kauaʻi	45410	22.2702218	-159.5940563	S06	Rubber Duck	Camera
09/16/2022	Kauaʻi	45410	22.2702218	-159.5940563	S06	Rubber Duck	Camera
09/16/2022	Kauaʻi	44496	22.1927722	-159.7537907	S13	Rubber Duck	Camera
09/16/2022	Kauaʻi	44496	22.1927722	-159.7537907	S13	Rubber Duck	Camera
09/16/2022	Kauaʻi	44451	22.1881875	-159.7683165	S06	Rubber Duck	Camera
09/16/2022	Kauaʻi	44451	22.1881875	-159.7683165	S06	Rubber Duck	Camera
09/16/2022	Kauaʻi	44083	22.1429037	-159.7923133	S01	Rubber Duck	Camera
09/16/2022	Kauaʻi	44083	22.1429037	-159.7923133	S01	Rubber Duck	Camera
09/16/2022	Kauaʻi	45305	22.2570408	-159.4823903	S01	Steel Toe	Camera
09/16/2022	Kauaʻi	45305	22.2570408	-159.4823903	S01	Steel Toe	Camera
09/16/2022	Kauaʻi	45495	22.2838595	-159.5698463	S09	Steel Toe	Camera
09/16/2022	Kauaʻi	45495	22.2838595	-159.5698463	S09	Steel Toe	Camera
09/16/2022	Kauaʻi	44511	22.1930927	-159.6810379	S10	Steel Toe	Camera
09/16/2022	Kauaʻi	44511	22.1930927	-159.6810379	S10	Steel Toe	Camera
09/16/2022	Kauaʻi	44408	22.1836247	-159.7779916	S09	Steel Toe	Camera

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09/16/2022	Kauaʻi	44408	22.1836247	-159.7779916	S09	Steel Toe	Camera
09/16/2022	Kauaʻi	45085	22.2430115	-159.6230541	S11	Sette	Camera
09/16/2022	Kauaʻi	45085	22.2430115	-159.6230541	S11	Sette	Camera
09/16/2022	Kauaʻi	43990	22.1292581	-159.8116291	S05	Sette	Camera
09/16/2022	Kauaʻi	43990	22.1292581	-159.8116291	S05	Sette	Camera
09/17/2022	Niʻihau	42373	21.9426966	-160.0526449	S02	Rubber Duck	Camera
09/17/2022	Niʻihau	42373	21.9426966	-160.0526449	S02	Rubber Duck	Camera
09/17/2022	Niʻihau	40654	21.8024634	-160.0854738	S16	Rubber Duck	Camera
09/17/2022	Niʻihau	40654	21.8024634	-160.0854738	S16	Rubber Duck	Camera
09/17/2022	Niʻihau	39921	21.742625	-160.2445647	S12	Rubber Duck	Camera
09/17/2022	Niʻihau	39921	21.742625	-160.2445647	S12	Rubber Duck	Camera
09/17/2022	Niʻihau	42818	21.9743743	-160.0431932	S12	Steel Toe	Camera
09/17/2022	Niʻihau	42818	21.9743743	-160.0431932	S12	Steel Toe	Camera
09/17/2022	Niʻihau	42004	21.9111116	-160.0475722	S10	Steel Toe	Camera
09/17/2022	Niʻihau	42004	21.9111116	-160.0475722	S10	Steel Toe	Camera
09/17/2022	Niʻihau	40674	21.806419	-160.1677286	S14	Steel Toe	Camera
09/17/2022	Niʻihau	40674	21.806419	-160.1677286	S14	Steel Toe	Camera
09/17/2022	Niʻihau	41007	21.847629	-160.0858146	S05	Sette	Camera
09/17/2022	Niʻihau	41007	21.847629	-160.0858146	S05	Sette	Camera
09/18/2022	Niʻihau	43309	22.0236429	-160.1065278	S10	Rubber Duck	Camera
09/18/2022	Niʻihau	43309	22.0236429	-160.1065278	S10	Rubber Duck	Camera
09/18/2022	Niʻihau	43109	22.0052432	-160.1548197	S16	Rubber Duck	Camera
09/18/2022	Niʻihau	43109	22.0052432	-160.1548197	S16	Rubber Duck	Camera
09/18/2022	Niʻihau	41986	21.9096917	-160.2508509	S07	Rubber Duck	Camera
09/18/2022	Niʻihau	43218	22.0146101	-160.1064576	S02	Steel Toe	Camera
09/18/2022	Niʻihau	43218	22.0146101	-160.1064576	S02	Steel Toe	Camera
09/18/2022	Niʻihau	43062	22.0007609	-160.1499401	S05	Steel Toe	Camera
09/18/2022	Niʻihau	43062	22.0007609	-160.1499401	S05	Steel Toe	Camera
09/18/2022	Niʻihau	41986	21.9096917	-160.2508509	S07	Steel Toe	Camera
09/19/2022	Kauaʻi	41136	21.8594938	-159.495561	S01	Rubber Duck	Camera
09/19/2022	Kauaʻi	41136	21.8594938	-159.495561	S01	Rubber Duck	Camera
09/19/2022	Kauaʻi	41841	21.8995705	-159.6602731	S16	Rubber Duck	Camera
09/19/2022	Kauaʻi	41841	21.8995705	-159.6602731	S16	Rubber Duck	Camera
09/19/2022	Kauaʻi	42108	21.9220967	-159.6749002	S02	Rubber Duck	Camera
09/19/2022	Kauaʻi	42108	21.9220967	-159.6749002	S02	Rubber Duck	Camera
09/19/2022	Kauaʻi	43091	22.0028118	-159.8060637	S07	Rubber Duck	Camera
09/19/2022	Kauaʻi	43091	22.0028118	-159.8060637	S07	Rubber Duck	Camera
09/20/2022	Kauaʻi	43769	22.0903922	-159.2734019	S10	Sette	Camera
09/20/2022	Kauaʻi	43769	22.0903922	-159.2734019	S10	Sette	Camera
09/20/2022	Kauaʻi	43201	22.0135213	-159.3168537	S14	Sette	Camera
09/20/2022	Kauaʻi	43201	22.0135213	-159.3168537	S14	Sette	Camera
09/21/2022	Oʻahu	38368	21.6232418	-158.1661631	S14	Rubber Duck	Camera

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09/21/2022	Oʻahu	38368	21.6232418	-158.1661631	S14	Rubber Duck	Camera
09/21/2022	Oʻahu	37362	21.5514454	-158.2679749	S04	Rubber Duck	Camera
09/21/2022	Oʻahu	37362	21.5514454	-158.2679749	S04	Rubber Duck	Camera
09/21/2022	Oʻahu	37362	21.5514454	-158.2679749	S04	Rubber Duck	Camera
09/21/2022	Oʻahu	37090	21.5106833	-158.2440427	S03	Rubber Duck	Camera
09/21/2022	Oʻahu	37090	21.5106833	-158.2440427	S03	Rubber Duck	Camera
09/21/2022	Oʻahu	38289	21.6186515	-158.1516971	S05	Steel Toe	Camera
09/21/2022	Oʻahu	38289	21.6186515	-158.1516971	S05	Steel Toe	Camera
09/21/2022	Oʻahu	38270	21.6190943	-158.2434804	S16	Steel Toe	Camera
09/21/2022	Oʻahu	38270	21.6190943	-158.2434804	S16	Steel Toe	Camera
09/21/2022	Oʻahu	37289	21.5423684	-158.2583638	S16	Steel Toe	Camera
09/21/2022	Oʻahu	37289	21.5423684	-158.2583638	S16	Steel Toe	Camera
09/21/2022	Oʻahu	38250	21.6195058	-158.3400969	S17	Sette	Camera
09/21/2022	Oʻahu	38251	21.6194865	-158.335266	S13	Sette	Camera
09/21/2022	Oʻahu	37625	21.5834436	-158.3595795	S15	Sette	Camera
09/21/2022	Oʻahu	37625	21.5834436	-158.3595795	S15	Sette	Camera
09/23/2022	Oʻahu	38314	21.6169205	-157.8618724	S11	Rubber Duck	Camera
09/23/2022	Oʻahu	38314	21.6169205	-157.8618724	S11	Rubber Duck	Camera
09/23/2022	Oʻahu	39216	21.6848333	-157.8855033	S14	Rubber Duck	Camera
09/23/2022	Oʻahu	39216	21.6848333	-157.8855033	S14	Rubber Duck	Camera
09/23/2022	Oʻahu	39509	21.7130936	-158.0738023	S08	Rubber Duck	Camera
09/23/2022	Oʻahu	39509	21.7130936	-158.0738023	S08	Rubber Duck	Camera
09/23/2022	Oʻahu	37830	21.5897212	-157.8475966	S01	Steel Toe	Camera
09/23/2022	Oʻahu	37830	21.5897212	-157.8475966	S01	Steel Toe	Camera
09/23/2022	Oʻahu	38966	21.6622503	-157.8856769	S05	Steel Toe	Camera
09/23/2022	Oʻahu	38966	21.6622503	-157.8856769	S05	Steel Toe	Camera
09/23/2022	Oʻahu	39746	21.7310517	-158.0543495	S09	Steel Toe	Camera
09/23/2022	Oʻahu	39746	21.7310517	-158.0543495	S09	Steel Toe	Camera
09/23/2022	Oʻahu	39778	21.7300961	-157.8996574	S16	Sette	Camera
09/23/2022	Oʻahu	39778	21.7300961	-157.8996574	S16	Sette	Camera
09/23/2022	Oʻahu	39717	21.7256116	-157.9045256	S07	Sette	Camera
09/23/2022	Oʻahu	39717	21.7256116	-157.9045256	S07	Sette	Camera
09/24/2022	Maui Nui	25478	21.0294294	-157.2890962	S07	Rubber Duck	Camera
09/24/2022	Maui Nui	25478	21.0294294	-157.2890962	S07	Rubber Duck	Camera
09/24/2022	Maui Nui	25752	21.0346561	-157.361195	S04	Rubber Duck	Camera
09/24/2022	Maui Nui	25752	21.0346561	-157.361195	S04	Rubber Duck	Camera
09/24/2022	Maui Nui	24057	21.0080616	-157.4143937	S05	Rubber Duck	Camera
09/24/2022	Maui Nui	24057	21.0080616	-157.4143937	S05	Rubber Duck	Camera
09/24/2022	Maui Nui	25485	21.0290873	-157.2554282	S10	Steel Toe	Camera
09/24/2022	Maui Nui	25485	21.0290873	-157.2554282	S10	Steel Toe	Camera
09/24/2022	Maui Nui	23292	20.9937794	-157.3375951	S16	Steel Toe	Camera
09/24/2022	Maui Nui	23292	20.9937794	-157.3375951	S16	Steel Toe	Camera

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09/24/2022	Maui Nui	21783	20.967327	-157.4052065	S16	Steel Toe	Camera
09/24/2022	Maui Nui	21783	20.967327	-157.4052065	S16	Steel Toe	Camera
09/24/2022	Maui Nui	22765	20.9857033	-157.4386756	S10	Sette	Camera
09/24/2022	Maui Nui	22765	20.9857033	-157.4386756	S10	Sette	Camera
09/25/2022	Maui Nui	25239	21.0216522	-156.9909786	S01	Rubber Duck	Camera
09/25/2022	Maui Nui	25239	21.0216522	-156.9909786	S01	Rubber Duck	Camera
09/25/2022	Maui Nui	24386	21.0084453	-157.02001	S14	Rubber Duck	Camera
09/25/2022	Maui Nui	24386	21.0084453	-157.02001	S14	Rubber Duck	Camera
09/25/2022	Maui Nui	25519	21.0266175	-157.0293894	S16	Rubber Duck	Camera
09/25/2022	Maui Nui	25519	21.0266175	-157.0293894	S16	Rubber Duck	Camera
09/25/2022	Maui Nui	27911	21.0633445	-157.0818264	S05	Rubber Duck	Camera
09/25/2022	Maui Nui	27911	21.0633445	-157.0818264	S05	Rubber Duck	Camera
09/25/2022	Maui Nui	21588	20.9573413	-156.9005001	S01	Steel Toe	Camera
09/25/2022	Maui Nui	21588	20.9573413	-156.9005001	S01	Steel Toe	Camera
09/25/2022	Maui Nui	24112	21.0038742	-157.0152614	S13	Steel Toe	Camera
09/25/2022	Maui Nui	24112	21.0038742	-157.0152614	S13	Steel Toe	Camera
09/25/2022	Maui Nui	25522	21.0264496	-157.0149626	S10	Steel Toe	Camera
09/25/2022	Maui Nui	25522	21.0264496	-157.0149626	S10	Steel Toe	Camera
09/25/2022	Maui Nui	20677	20.9410505	-157.0497397	S05	Sette	Camera
09/25/2022	Maui Nui	20677	20.9410505	-157.0497397	S05	Sette	Camera
09/25/2022	Maui Nui	20478	20.9365902	-157.0546043	S07	Sette	Camera
09/25/2022	Maui Nui	20478	20.9365902	-157.0546043	S07	Sette	Camera
09/25/2022	Maui Nui	20876	20.94573	-157.0641006	S14	Sette	Camera
09/25/2022	Maui Nui	20876	20.94573	-157.0641006	S14	Sette	Camera
10/03/2022	Oʻahu	33609	21.2568793	-158.076684	S11	Rubber Duck	Camera
10/03/2022	Oʻahu	33609	21.2568793	-158.076684	S11	Rubber Duck	Camera