Iran. J. Ichthyol. (September 2019), 6(3): 197-207
© 2019 Iranian Society of Ichthyology
P-ISSN: 2383-1561; E-ISSN: 2383-0964
http://www.ijichthyol.org

Received: December 7, 2018
Accepted: April 29, 2019
doi: 10.22034/iji.v6i3.353

Research Article

Comparison of baited remote underwater video (BRUV) and underwater visual census (UVC) for assessment of reef fish in a marginal reef in the northern Persian Gulf

Amir GHAZILOU[1]. Mohammad Reza SHOKRI[*2], William GLADSTONE[3]
[1]Iranian National Institute for Oceanography and Atmospheric Science (INIOAS), Tehran, Iran.
[2]Department of Aquatic Biology and Biotechnology, Faculty of Life Sciences and Biotechnology, Shahid Beheshti University, G.C, Evin, Tehran 1983963113, IR, Iran.
[3]School of Life Sciences, University of Technology Sydney, Broadway, NSW 2007, Australia.
[*]*Email:* m_shokri@sbu.ac.ir

Abstract: Underwater Visual Census (UVC) and Baited Remote Underwater Video (BRUV) are broadly used methods to study fish assemblages in marine and estuarine environments. This study compared the results of BRUV and UVC methods for assessing seasonal trends in coral reef fish assemblages in a marginal reef in the northern Persian Gulf. In doing so, seasonal surveys of coral reef fishes were done using BRUV and UVC methods. Comparison of assemblage metrics driven from each method indicated that both methods may reveal similar patterns of seasonal changes in fish and trophic group assemblages while there may be between-method differences in species richness, total abundance, and trophic group abundances. The observed differences may be related to the longer sampling times of BRUV.

Keywords: Fish abundance, Temporal variation, SCUBA diving, Video, Animal bait.

Citation: Ghazilou, A.; Shokri, M.R. & Gladstone, W. 2019. Comparison of baited remote underwater video (BRUV) and underwater visual census (UVC) for assessment of reef fish in a marginal reef in the northern Persian Gulf. Iranian Journal of Ichthyology 6(3): 197-207.

Introduction

Fishes of the coral reefs are susceptible to threat by anthropogenic activities (Robinson et al. 2017; Ruppert et al. 2018). The negative effects of human activity on coral reef fishes may be highlighted by drastic spatial and temporal changes in their distribution, abundance and species richness. As such, timely monitoring is needed to assess and manage these effects (Heenan et al. 2017). Both fishery-dependent and fishery-independent methods can be used for this purpose, yet fishery-independent methods may be more appropriate for performing surveys in areas with fishing restrictions enforcements (e.g. marine parks) (Ochwada-Doyle et al. 2016). The Baited Remote Underwater Video (BRUV) technique has become a popular tool for monitoring fish assemblages in marine protected areas (Harasti et al. 2019), deep sea (Sih et al. 2017), rough environments (Cappo et al. 2006), and estuaries (Gilby et al. 2017; Lowry et al. 2012).

The BRUV filming unit generally comprises single or paired camera(s) positioned horizontally or vertically (Langlois et al. 2018). Given the use of bait in BRUV methodology, one may expect to observe more specialist fish than the generalist ones (Wraith et al. 2013; Ghazilou et al. 2016). As such, comparative approaches have been taken to assess the efficiency of the BRUV technique in sampling the whole fish assemblages. These studies mainly include comparisons between BRUV and the underwater visual census (UVC) methods. For example, the results of some previous studies indicated that the BRUV detects higher number of fish species and higher abundance of fish, when compared to the UVC method (Langlois et al. 2006; Andradi-Brown et al. 2016). In contrast, Colton & Swearer (2010) found higher species richness, total fish abundance, and herbivore abundance in UVC surveys while the BRUV method tend to present higher abundance of mobile predators. On the other hand, some studies reported similar assemblage structures of fish communities obtained from BRUV and UVC surveys (Westera et al. 2003; Bosch et al. 2017).

Albeit inherent complexities in accuracy and precision of the BRUV data, this method has been successfully used to monitor seasonal changes in fish abundance. For example, Brooks et al. (2011) recorded significantly higher number of lemon sharks in winter using the BRUV method while the use of long-line method revealed no significant seasonal changes in their abundance. Jabado et al. (2018) found seasonal differences in the abundances of *Chiloscyllium arabicum* in the Persian Gulf and Willis et al. (2003) found a clear seasonal trend in abundance of *Pagrus auratus*, using this the BRUV method. In a recent study, the BRUV has been successfully applied to assess seasonal habitat use by *Chrysophrys auratus* (Terres et al. 2015). Our study was designed to examine the efficacy of the BRUV method to discriminate seasonal changes in the assemblage matrices of coral reef fish in the northern Persian Gulf. This was done by taking a comparative approach in which the results of BRUV and UVC techniques were compared.

Materials and Methods

Study area: The study was conducted within the Nayband marine park in the northern Persian Gulf (27°22'14.5338"N, 52°35'37.9566"E, Fig. 1). Coral reefs of the area were characterized by patches of *Platygyra* and *Porites* corals, mainly occurring at 3-8m depths.

Experimental design: Seasonal surveys of reef fish assemblages were conducted from fall 2015 to summer 2016, using BRUV and UVC methods. Total of 12 BRUV deployments and 12 UVC surveys were performed in each season. The standard belt transect method was used for performing UVCs (Hodgson et al. 2006). In doing so, a 100m tape measure was laid straight on the seafloor at ca. 6m depth and fish

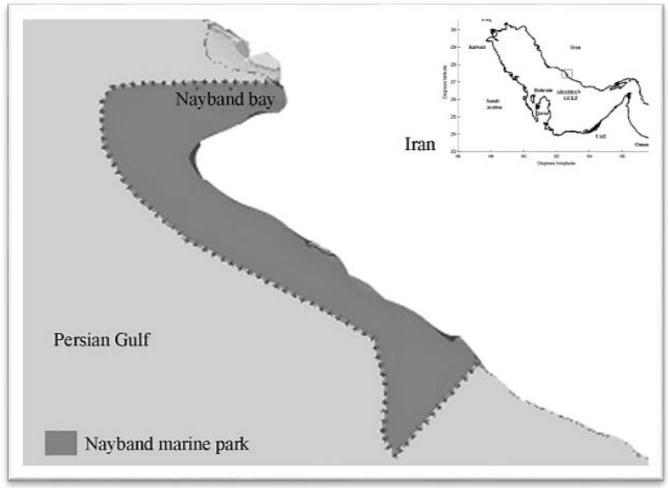

Fig.1. A map of sampling area in the northern Persian Gulf.

counts were recorded along four intermittent segments of 25m long (i.e. 0-20, 25-45, 50-70 and 75-95m) and 5m wide.

A single video recording system was used for BRUV deployments. The filming apparatus consisted of a GoPro HERO 3 Black Edition camera fixed inside a stainless steel frame at a forward-facing direction and a bait bag which mounted on the frame, using a bait rod (see Ghazilou et al. 2016 for further details). For each deployment, a 200g of fresh tuna (*Thunnus albacares*) was used as a bait. Successive deployments were performed at 20min intervals and were >100m apart (Ghazilou et al. 2016). Each cast included a 60min video recording session. In the laboratory, the videos were observed using VSO media player and the abundance of each species was recorded based on the MaxN metric (Willis et al. 2000). The species were then assigned to three trophic groups i.e. herbivores, planktivores / invertivores (P/I), and carnivores according to Halpern (2003) and their abundances were summed up to get the abundance of each trophic group.

The BRUV and UVC surveys were conducted randomly during daylight hours. Prior to each survey, water clarity and temperature were measured using a Secchi disk and a portable meter, respectively.

Statistical analyses: Generalized linear models (with Poisson log-linear link function) followed by

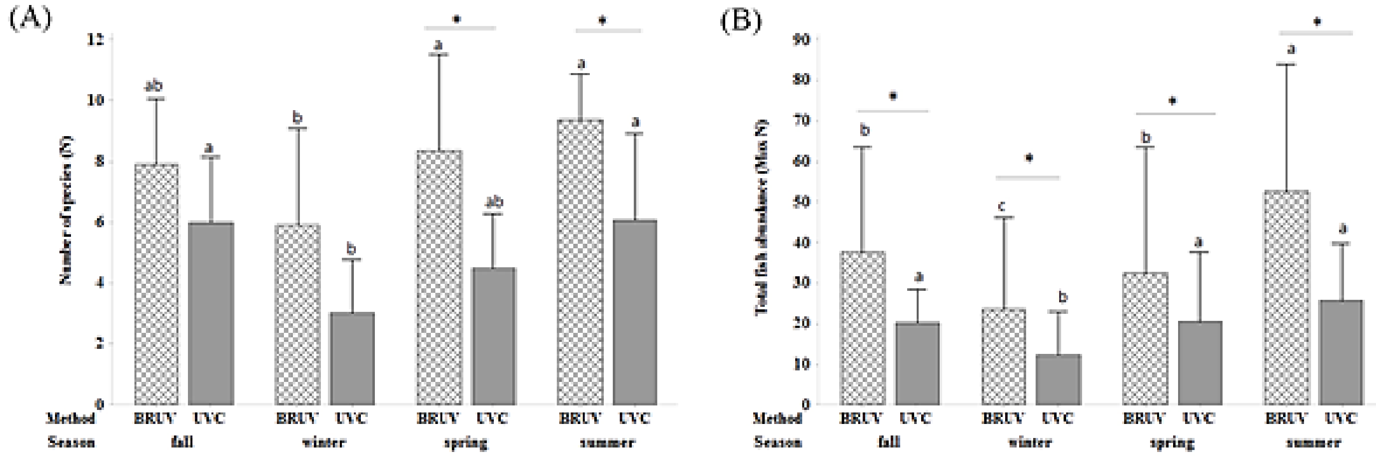

Fig.2. Seasonal differences in species richness and total abundances of fish assemblages. Dissimilar letters indicate significant between-season difference at $P<0.05$ level. The asterisks indicate significant between-method difference in each season. Error bars: confidence intervals.

Bonferroni pairwise comparison tests were used to analyze univariate data (fixed factors: season, survey method; covariates: water temperature, Secchi depth). For each analysis, ratios of a deviance goodness of fit to degree of freedom were used to check for over-dispersion (Dean & Lundy 2016) and for values> 1, a Pearson Chi-square scale parameter were applied to correct for over-dispersion (Kim & Margolin 1992).

Two-factor permutational analyses of variance (PERMANOVA) with season and survey method as fixed factors and water temperature and Secchi depth as covariates were used to analyze multivariate data (i.e. species/trophic composition and assemblage/ trophic structure) (Anderson 2001). PERMANOVAs were performed using 9999 permutations of residuals under a reduced model. Analyses were conducted on Bray–Curtis resemblance matrices of presence/ absence (P/A) (i.e. species and trophic composition) or square root-transformed abundance data (i.e. assemblage and trophic structure). Prior to each test, a PERMDISP routine was used to assess the homogeneity of variances. In the case of a significant pairwise difference followed by the PERMANOVAs, a SIMPER routine was used to determine which fish family was the main contributor to the observed pairwise seasonal difference. In each case, values of average dissimilarity>3 and dissimilarity/standard deviation> 1 were considered as criteria for significant contribution of the examined taxa to the observed pairwise difference (Malcolm et al. 2007). The multivariate patterns were illustrated using nonmetric multidimensional scaling (nMDS).

Results

Number of species: Overall, 28 fish species assigning to 24 families were observed during the study amongst which seven families *viz.* Belonidae (*Strongylura strongylura*), Dasyatidae (e.g. *Pastinachus sephen*), Carcharhinidae (*Carcharhinus melanopterus*), Siganidae (*Siganus sutor*), Torpedinidae (*Torpedo panthera*), Myliobatidae (*Aetobatus narinari*) and Gobiidae (*Amblyeleotris* sp.) were only recorded in BRUV video and the Cirrhitidae (*Oxycirrhites* sp.) was merely seen during UVC surveys. The results of GLMs indicated significant effects of season (Wald Chi-Square= 20.85; P= 0.001), survey method (Wald Chi-Square= 29.15; P= 0.001) and their interaction (Wald Chi-Square= 100.56; P= 0.0001) on mean number of observed fish species. This was highlighted by significantly lower number of fish species recorded using the UVC method in spring and summer, thereby resulting in different seasonal pattern depicted by each method (Fig. 2).

Total abundance and abundance of trophic groups: Similar to the species richness data, there were

Table 1. Analyses of season and survey-method effects on trophic group abundance.

		Wald Chi-Square	*p*- value
Herbivore abundance	Season	70.27	0.001
	Method	31.73	0.02
	Season× Method	150.56	0.0001
Carnivore abundance	Season	36.34	0.001
	Method	125.06	0.0001
	Season× Method	219.08	0.0001
P/I abundance	Season	24.59	0.0001
	Method	261.10	0.0001
	Season× Method	335.46	0.0001

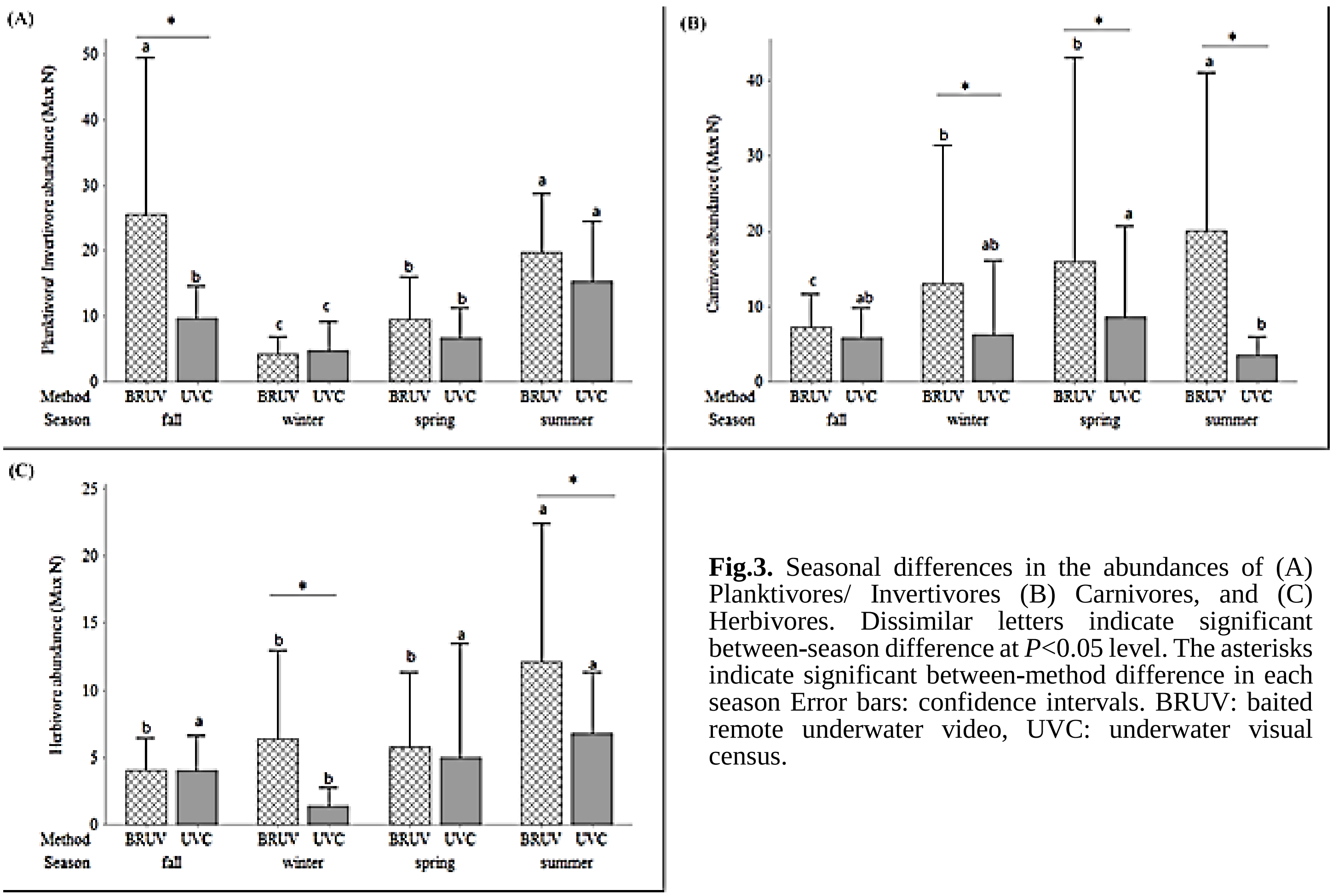

Fig.3. Seasonal differences in the abundances of (A) Planktivores/ Invertivores (B) Carnivores, and (C) Herbivores. Dissimilar letters indicate significant between-season difference at $P<0.05$ level. The asterisks indicate significant between-method difference in each season Error bars: confidence intervals. BRUV: baited remote underwater video, UVC: underwater visual census.

significant between-method (Wald Chi-Square= 212.89; P=0.001) and seasonal (Wald Chi-Square= 168.92; P= 0.001) differences in total fish abundance. The interactive term was also significant in the model (Wald Chi-Square= 387.26; P=0.001). In all seasons, the BRUV sampled significantly more fish than UVC (Fig. 2). The former method also revealed more complicated patterns of seasonal differences in total fish abundances (Fig. 2).

According to the results obtained, a large fraction of the observed fish included P/Is. There were significant effects of season, survey method, and their interactive term on abundance of all trophic groups (Table 1).

The observed between-method differences in abundance of trophic groups mainly included higher records in BRUV deployments (Fig. 3). There were more cases of between-method differences in

Table 2. PERMANOVA table of composition and structure of fish assemblages in the Nayband marine park.

		PERMANOVA		*PERMDISP*	
		Pseudo-F	$P_{(perm)}$	*F*	$P_{(perm)}$
	Season	3.7	0.0003	14.149	0.0001
Species composition	Method	12.2	0.0001	7.3803	0.033
	Season× Method	1.6	0.0807	-	-
	Season	3.7	0.0001	10.319	0.0001
Assemblage structure	Method	7.8	0.0001	3.1802	0.18
	Season× Method	1.4	0.11	-	-

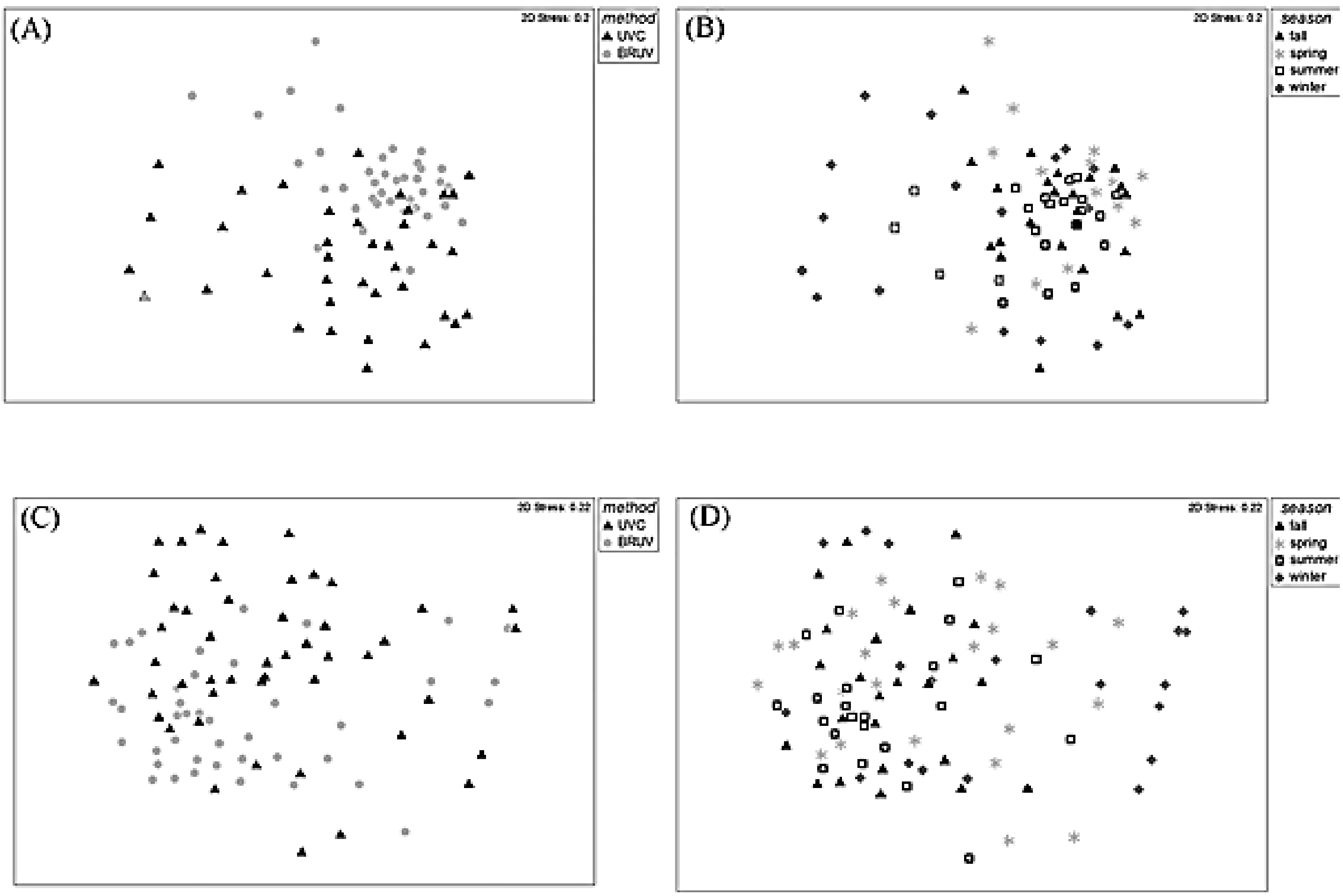

Fig.4. Nonmetric multidimensional scaling (nMDS) ordination of fish assemblages showing moderate separation in composition (A) and structure (C) of assemblages obtained from BRUV and UVC data and the overall seasonal separation in species composition (B) and assemblage structure (D). BRUV: baited remote underwater video, UVC: underwater visual census.

carnivore abundance data, compared to herbivore or P/I abundances (Fig. 3). The BRUV also revealed more complicated seasonal patterns in trophic group abundances (Fig. 3).

Species composition and assemblage structure: The nMDS plots of species composition and assemblage structure indicated weak separations among seasons and moderate separations between survey methods (Fig. 4). The results of PERMANOVAs indicated significant effects of both factors (i.e. survey method and season) on composition and structure of fish assemblages but their interactions were not significant (Table 2). Higher abundance of Carangidae (e.g. *Carangoides bajad*) and Lutjanidae (e.g. *Lutjanus fulviflamma*) mainly contributed to the observed between-method differences in assemblage

Table 3. Pair-wise seasonal difference in species composition and structure of assemblages. SIMPER: the main fish families contributing to the observed seasonal differences.

Comparisions	t- statistic	$P_{(perm)}$	*SIMPER*					
			family	*Av.Abund (G1)*	*Av.Abund (G2)*	*Avg. diss.*	*Diss/SD*	*Cont.*
Fall* Spring	1.65	0.01	Chaetodontidae	1.50	0.93	7.38	1.16	11.84
Fall* Summer	1.57	0.01	Nemipteridae	0.83	1.11	6.45	1.16	11.61
Fall* Winter	2.25	0.0009	Chaetodontidae	1.50	0.61	9.29	1.08	13.32
Spring*Summer	1.73	0.01	Lutjanidae	0.81	1.14	6.92	1.01	11.43
Spring* Winter	1.58	0.04	Pomacanthidae	1.03	0.56	7.40	1.06	10.12
Summer* Winter	2.58	0.0001	Pomacanthidae	1.64	0.56	8.39	1.15	12.01

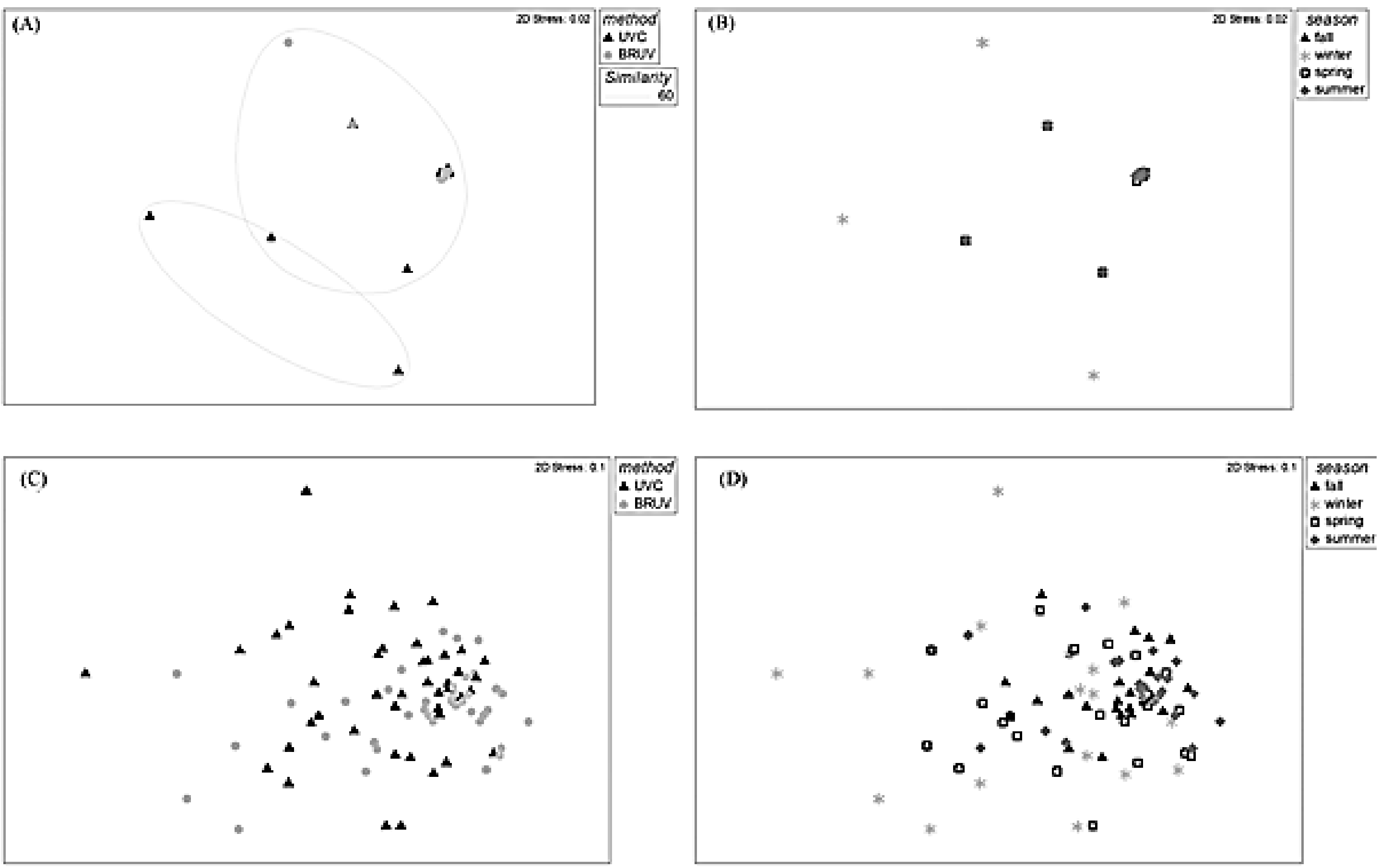

Fig.5. Nonmetric multidimensional scaling (nMDS) ordination of trophic groups showing (A) between-method and (B) seasonal variations in trophic composition and (C) between-method and (D) seasonal variations in trophic structure of trophic assemblages.

structure.

The differences in structure of fish assemblages was significant among all seasons (Table 3). The Nemipteridae (*Scolopsis ghanam*), Chaetodontidae (*Chaetodon nigropunctatus*), Lutjanidae, and Pomacanthidae (*Pomacanthus maculosus*) were the most responsible families for the observed seasonal differences in the assemblage structure (Table 3).

Trophic composition and structure: The nMDS plots based on P/A data of trophic groups indicated moderate separation between BRUV and UVC samples while a rather weak separation of seasonal data could be depicted (Fig. 5). Plots of trophic group abundances did not illustrate any signs of between-method or seasonal difference in trophic assemblages (Fig. 5).

Table 4. PERMANOVA table of trophic composition and structure. SIMPER: the main fish families contributing to the observed between-method differences.

Comparisions		*PERMANOVA*		*PERMDISP*	
		Pseudo-F	$P_{(perm)}$	F	$P_{(perm)}$
Trophic composition	Season	3.11	0.01	20.16	0.0001
	Method	5.45	0.01	9.94	0.03
	Season× Method	0.91	0.57		
Trophic structure	Season	5.02	0.02	15.49	0.0001
	Method	3.88	0.02	1.151	0.41
	Season× Method	0.64	0.73		

The results of PERMANOVA indicated no significant effects of season on composition or structure of trophic assemblages while the effects of survey method were significant in the model (Table 4). Higher abundances of both carnivores and herbivores mainly contributed to the observed discrepancy between examined methods (Table 4).

Discussion

The results indicated that BRUV method could, to some extent, be used as an efficient tool for monitoring the seasonal changes in reef fish assemblages. In our study, the use of BRUV and UVC methods depicted similar seasonal trends in the assemblage and trophic structure, while the use of each method revealed different patterns in univariate matrices of the sampled fish assemblages. The overall between-method differences in a number of fish families were highlighted by the presence of elasmobranchs in the video footages. Some earlier studies also reported comparatively higher diversity of fish assemblages using the BRUV method (e.g., Willis et al. 2000; Watson et al. 2005), while some others (e.g., Stobart et al. 2007; Colton & Swearer 2010; Lowry et al. 2012) recorded a higher number of fish families in UVC samples. Colton & Swearer (2010) concluded that the higher family richness in UVC surveys might be due to the relatively larger survey area covered by this method. Yet, the authors emphasized that the BRUV method may be more suitable for assessing sharks and rays. On the other hand, Brooks et al. (2011) compared the BRUV and long line method for surveying sharks around the Eleuthera, Bahamas and found that at least for less abundant species, the threshold abundance should be reached to make the BRUV estimates match with the long line data. Considering relatively shorter survey times for UVCs in our study (i.e., 7min for each transect compared to a 60min video recording for each BRUV deployment), one may expect to encounter fewer elasmobranchs in visual census trials, which are naturally less abundant in the area (Jabado et al. 2018). The deterring effect of scuba apparatus noise on elasmobranches seems to be less influential since elasmobranches and bony fish have a similar hearing range (Casper et al. 2003).

Our findings also indicated that the BRUV sampled a higher abundance of carnivores. Up until now, there has been an argument regarding the selective bias of the BRUV method toward carnivorous fish (Cappo 2010). The BRUV has been originally developed as a sampling tool for carnivorous fish (Willis & Babcock 2000), but later examinations revealed that the method may be efficiently used to record abundances of herbivorous fish as well (Watson et al. 2005; Cappo 2010). Yet, Cappo (2010) concluded that herbivorous fish tend to inhabit distant locations around the bait, probably due to the deterring effects of carnivores. In the present study, only near-field sightings (those fish inhabiting up to 3 m off the camera) were considered, but we did not find any significant between-method differences in the abundance of herbivorous fish during fall and summer and relatively higher abundances for BRUV-driven data during spring and winter. This might be due to the casual passing of these fish through the field of view in near-shore areas (Cappo et al. 2003). Yet, these between-method differences were strong enough to influence the efficiency of the examined methods in detecting seasonal dynamics of herbivorous fish abundance (and the abundances of carnivores or P/Is as well). Moreover, the accuracy of BRUV abundance estimates may also be affected by site-fidelity behavior of fish species (Colton 2011; Pais et al. 2017). In our study, hawkfishes were not recorded in video footages, while they were commonly observed during UVC surveys. These fish are highly attached to coral heads (Donaldson 1988). As such, they may not leave their territory to visit the bait.

In terms of fish assemblages, the exploration of in-season differences between BRUV and UVC methods indicated that schooling fishes (i.e., Lutjanidae, Carangidae) were more abundant in BRUV surveys. The BRUV may overestimate or underestimate the abundance of schooling fish. In the first case, a large bait plume may concentrate schools of fish from several habitats on the field of view, thereby resulting in high abundance estimates (Kiggins et al. 2018). Yet, in the case of large fish schools passing through, the field of view may become saturated, resulting in underestimates (Cappo 2010). Yet, these discrepancies were not strong enough to affect the discriminating efficiency of this method for detecting seasonal trends in the assemblage structure.

Acknowledgements

We would like to thank Shahid Beheshti University for financial support and DOE office in the Nay Band Bay (M. Hoseini) for their assistance in the field.

References

Anderson, M.J. 2001. A new method for non-parametric multivariate analysis of variance. Austral Ecology 26: 32-46.

Andradi-Brown, D.A.; Macaya-Solis, C.; Exton, D.A.; Gress, E.; Wright, G. & Rogers, A.D. 2016. Assessing Caribbean shallow and mesophotic reef fish communities using Baited-Remote Underwater Video (BRUV) and Diver-Operated Video (DOV) survey techniques. PLoS ONE 11(12): e0168235.

Bosch, N.E.; Gonçalves, J.M.S.; Tuya, F. & Erzini, K. 2017. Marinas as habitats for nearshore fish assemblages: comparative analysis of underwater visual census, baited cameras and fish traps. Scientia Marina 81(2): 159-169.

Brooks, E.J.; Sloman, K.A.; Sims, D.W. & Danylchuk, A.J. 2011. Validating the use of baited remote underwater video surveys for assessing the diversity, distribution and abundance of sharks in the Bahamas. Endangered Species Research 13: 231-243.

Cappo, M. 2010. Development of a baited video technique and spatial models to explain patterns of fish biodiversity in inter-reef waters. PhD thesis. James Cook University, North Queensland, Australia.

Cappo, M.; Harvey, E.; Malcolm, H. & Speare, P. 2003. Potential of video techniques to monitor diversity, abundance and size of fish in studies of marine protected areas. In: proceedings of the World Congress on Aquatic Protected Areas, August 2002, pp. 455-464.

Cappo, M.; Harvey, E. & Shortis, M. 2006. Counting and measuring fish with baited video techniques-an overview. In: proceedings of the Australian Society for Fish Biology Workshop, August 2007. pp. 101-114.

Casper, B.M.; Lobel, P.S. & Yan, H.Y. 2003. The hearing sensitivity of the little skate, *Raja erinacea*: a comparison of two methods. Environmental Biology of Fishes 68: 371-379.

Colton, M.A. 2011. Patterns in the distribution and abundance of reef fishes in South Eastern Australia. PhD thesis. The University of Melbourne, Parkville, Melbourne, Australia.

Colton, M.A. & Swearer, S.E. 2010. A comparison of two survey methods: differences between underwater visual census and baited remote underwater video. Marine Ecology Progress Series 400: 19-36.

Dean, C.B. & Lundy, E.R. 2016. *Overdispersion*. Wiley StatsRef: Statistics Reference Online. Wiley, USA.

Donaldson, T.J. 1988. Social organization, reproductive behavior, and zoogeography of some Indo-Pacific Hawkfishes (Cirrhitidae). PhD thesis. Louisiana State University, Louisiana, USA.

Ghazilou, A.; Shokri, M.R. & Gladstone, W. 2016. Animal v. plant-based bait: does the bait type affect census of fish assemblages and trophic groups by baited remote underwater video (BRUV) systems? Journal of Fish Biology 88: 1731-1745.

Gilby, B.L.; Olds, A.D.; Yabsley, N.A.; Connolly, R.M.; Maxwell, P.S. & Schlacher, T.A. 2017. Enhancing the performance of marine reserves in estuaries: Just add water. Biological Conservation 210: 1-7.

Halpern, B.S. 2003. The impact of marine reserves: do reserves work and does reserve size matter? Ecological Applications 13: 117-137.

Harasti, D.; Davis, T.R.; Jordan, A.; Erskine, L. & Moltschaniwskyj, N. 2019. Illegal recreational fishing causes a decline in a fishery targeted species (Snapper: Chrysophrys auratus) within a remote no-take marine protected area. PLoS ONE 14(1): e0209926.

Heenan, A.; Williams, I.D.; Acoba, T.; DesRochers, A.; Kosaki, R.K.; Kanemura, T.; Nadon, M.O. & Brainard, R.E. 2017. Long-term monitoring of coral reef fish assemblages in the Western central pacific. Scientific Data 4: 170176.

Hodgson, G.; Hill, J.; Kiene, W.; Maun, L.; Mihaly, J.; Liebeler, J.; Shuman, C. & Torres, R. (2006) Reef Check Instruction Manual: A Guide to Reef Check Coral Reef Monitoring. Reef Check Foundation, Pacific Palisades, California, USA. 95 p.

Jabado, R.W.; Al Hameli, S.M.; Grandcourt, E.M. & Al Dhaheri, S.S. 2018. Low abundance of sharks and rays in baited remote underwater video surveys in the Persian Gulf. Scientific Reports 8: 15597.

Kiggins, R.S.; Knott, N.A. & Davis, A.R. 2018. Miniature baited remote underwater video (mini-BRUV) reveals the response of cryptic fishes to seagrass cover. Environmental Biology of Fishes 101: 1717-1722.

Kim, B.S. & Margolin, B.H. 1992. Testing goodness of fit of a multinomial model against overdispersed alternatives. Biometrics 48: 711-719.

Langlois, T.; Chabanet, P.; Pelletier, D. & Harvey, E. 2006. Baited underwater video for assessing reef fish populations in marine reserves. Fisheries Newsletter-South Pacific Commission 118: 53.

Langlois, T.; Williams, J.; Monk, J.; Bouchet, P.; Currey, L.; Goetze, J.; Harasti, D.; Huveneers. C.; Ierodiaconou, D.; Malcolm, H. & Whitmarsh, S. 2018. *Marine sampling field manual for benthic stereo BRUVS (Baited Remote Underwater Videos). In: Field Manuals for Marine Sampling to Monitor Australian Waters, Version 1.* (eds Przeslawski, R. and Foster, S.). Canberra, Australia, NESP Marine Biodiversity Hub. pp. 82-104.

Lowry, M.; Folpp, H.; Gregson, M. & Suthers, I. 2012. Comparison of baited remote underwater video (BRUV) and underwater visual census (UVC) for assessment of artificial reefs in estuaries. Journal of Experimental Marine Biology and Ecology 416/417: 243-253.

Malcolm, H.A.; Gladstone, W.; Lindfield, S.; Wraith, J. & Lynch, T.P. 2007. Spatial and temporal variation in reef fish assemblages of marine parks in New South Wales. Marine Ecology Progress Series 350: 277-290.

Ochwada-Doyle, F.A.; Johnson, D.D. & Lowry, M. 2016. Comparing the utility of fishery-independent and fishery-dependent methods in assessing the relative abundance of estuarine fish species in partial protection areas. Fisheries Management and Ecology 23(5): 390-406.

Pais, M.P. & Cabral H.N. 2017. Fish behaviour effects on the accuracy and precision of underwater visual census surveys. A virtual ecologist approach using an individual-based model. Ecological Modelling 346: 58-69.

Robinson, J.P.W.; Williams, I.D.; Edwards, A.M.; McPherson, J.; Yeager, L.; Vigliola, L.; Brainard, R.E. & Baum, J.K. 2017. Fishing degrades size structure of coral reef fish communities. Global Change Biology 23(3): 1009-1022.

Ruppert, J.L.W.; Vigliola, L.; Kulbicki, M.; Labrosse, P.; Fortin, M.J. & Meekan, M.G. 2018. Human activities as a driver of spatial variation in the trophic structure of fish communities on Pacific coral reefs. Global Change Biology 24(1): e67-e79.

Sih, T.L.; Cappo, M. & Kingsford M. 2017. Deep-reef fish assemblages of the Great Barrier Reef shelf-break (Australia). Scientific Reports 7(1): 10886.

Stobart, B.; García-Charton, J.A.; Espejo, C.; Rochel, E.; Goñi, R.; Reñones, O.; Herrero, A.; Crec'hriou, R.; Polti, S.; Marcos, C.; Planes, S. & Pérez-Ruzafa, A. 2007. A baited underwater video technique to assess shallow-water Mediterranean fish assemblages: Methodological evaluation. Journal of Experimental Marine Biology and Ecology 345: 158-174.

Terres, M.A.; Lawrence, E.; Hosack, G.R.; Haywood, M.D.E. & Babcock, R.C. 2015. Assessing habitat use by Snapper (*Chrysophrys auratus*) from Baited underwater video data in a coastal marine park. PLoS ONE 10(8): e0136799.

Watson, D.L.; Harvey, E.S.; Anderson, M.J. & Kendrick, G.A. 2005. A comparison of temperate reef fish assemblages recorded by three underwater stereo-video techniques. Marine Biology 148: 415-425.

Westera, M.; Lavery, P. & Hyndes, G. 2003. Differences in recreationally targeted fishes between protected and fished areas of a coral reef marine park. Journal of Experimental Marine Biology and Ecology 294: 145-168.

Willis, T.J. & Babcock, R.C. 2000. A baited underwater video system for the determination of relative density of carnivorous reef fish. Marine and Freshwater Research 51: 755-763.

Willis, T.J.; Millar, R.B. & Babcock, R.C. 2000. Detection of spatial variability in relative density of fishes: comparison of visual census, angling, and baited underwater video. Marine Ecology Progress Series 198: 249-260.

Willis, T.J.; Millar, R.B. & Babcock, R.C. 2003. Protection of exploited fish in temperate regions: high density and biomass of snapper *Pagrus auratus* (Sparidae) in northern New Zealand marine reserves. Journal of Applied Ecology 40: 214-227.

Wraith, J.; Lynch, T.; Minchinton, T.E.; Broad, A. & Davis, A.R.. 2013. Bait type affects fish assemblages and feeding guilds observed at baited remote underwater video stations. Marine Ecology Progress Series 477: 189-199.

Iran. J. Ichthyol. (September 2019), 6(3): 197–207
© 2019 Iranian Society of Ichthyology
P-ISSN: 2383-1561; E-ISSN: 2383-0964
http://www.ijichthyol.org

Received: December 7, 2018
Accepted: April 29, 2019
doi: 10.22034/iji.v6i3.353

مقاله پژوهشی

مقایسه دو روش تصویربرداری از راه دور مجهز به طعمه و مشاهده مستقیم در ارزیابی تغییرات فصلی اجتماعات ماهیان مرجانی منطقه حفاظت شده نایبند (خلیج فارس)

امیر قاضی‌لو[1]، محمدرضا شکری*[2]، ویلیام گلادستون[3]

[1]پژوهشگاه ملی اقیانوس‌شناسی و علوم جوی، تهران، ایران.
[2]گروه زیست‌شناسی و بیوتکنولوژی آبزیان، دانشکده علوم زیستی و بیوتکنولوژی، دانشگاه شهید بهشتی، تهران، ایران.
[3]مدرسه علوم زیستی، دانشگاه تکنولوژی سیدنی، برودوی، استرالیا.

چکیده: روش تصویربرداری از راه دور مجهز به طعمه از روش‌های مرسوم در پایش اجتماعات ماهیان مرجانی مناطق حفاظت شده دریایی به شمار می‌آید. مطالعه حاضر با هدف ارزیابی کارایی روش مذکور در پایش تغییرات فصلی این اجتماعات در یکی از مناطق حفاظت شده دریایی خلیج فارس به انجام رسید. برای این منظور، پایش فصلی اجتماعات ماهیان مرجانی منطقه با استفاده از دو روش تصویربرداری از راه دور مجهز به طعمه و مشاهده مستقیم صورت گرفت. نتایج مقایسه پارامترهای حاصله موید کارایی یکسان هر دو روش در سنجش الگوی تغییرات فصلی ساختار اجتماعات ماهیان و گروه‌های تغذیه‌ای بود. این در حالیست که تفاوت معنی‌داری در تعداد گونه‌ها، فراوانی کل ماهیان و فراوانی گروه‌های تغذیه‌ای بدست آمده از دو روش وجود داشت. این تفاوت را شاید بتوان به طولانی‌تر بودن مدت پایش در روش اول نسبت داد.

کلمات‌کلیدی: فراوانی ماهیان، تغییرات زمانی، غواصی، طعمه گوشتی، ویدئو.