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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Barotrauma treatment performance of fish release devices and its effects on fishing operations

Balık bırakma takımlarının barotravma tedavi performansı ve balıkçılık operasyonlarına etkileri

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Abstract: The aim of this study is to analyze the barotrauma treatment performance of different fish release devices and its effects on different fishing operations. Experiments were carried out between September 2017 and April 2018 in the Iskenderun Bay, located in the Eastern Mediterranean. Fishing Release Hook (FRH), Fish Release Clamp (FRC) and Fish Release Basket (FRB) were tested in three different fishing activities, which are longline, hand line and bottom trawl fishery, respectively for *Epinephelus aeneus*, *Epinephelus costae* and *Nemipterus randalli*. They were released into the sea after fishing operations. Study results showed that fish release devices were very effective for barotrauma treatment. The use of FRB is suitable for bottom trawl fishing, while the use of FRH and FRC is more ergonomic in longline and hand line fishery.

Keywords: *Fish release devices, barotrauma treatment, trawl, longline, hand line*

Öz: Bu çalışmanın amacı, farklı balık bırakma takımlarının barotravma tedavi performansını ve farklı balıkçılık operasyonlarına etkilerini analiz etmektir. Çalışma, Eylül 2017 ile Nisan 2018 arasında Doğu Akdeniz›de yer alan İskenderun Körfezinde gerçekleştirilmiştir. Bu çalışmada, parakete, olta ve dip trol balıkçılığı olmak üzere üç farklı balıkçılık faaliyetinde Balık Bırakma Oltası (BBO), Balık Bırakma Kıskacı (BBK) ve Balık Bırakma Sepeti (BBS) olmak üzere üç adet balık bırakma takımı kullanılmıştır. *Epinephelus aeneus*, *Epinephelus costae* ve *Nemipterus randalli* türlerinin bireyleri balıkçılık operasyonlarından sonra denize bırakılmıştır. Çalışma sonuçları balık bırakma takımlarının barotravma tedavisi için çok etkili olduğunu göstermiştir. BBS kullanımı dip trol avcılığına uygunken BBO ve BBK ise parakete ve olta balıkçılığında daha kullanışlıdır.

Anahtar kelimeler: *Balık bırakma takımları, barotravma tedavisi,trol, parakete, olta*

INTRODUCTION

Developing fishing technology is an important issue for ecological sustainability (Prellezo and Curtin, 2015). The mitigation of non-target catch and the determination of its effects cover an important part of fishing technology researches (Cooke et al., 2016; Cook et al., 2019). The non-target catch involves the capture of fully banned by marine species and small species of economic targets that they are mostly under minimum legal catch size (Lloret et al., 2018; Şimşek and Demirci, 2018; Karp et al., 2019).

The concept of discard mitigation shows sustainability in the use of resources as ecosystem-based fisheries (Long et al., 2015; Kenny et al., 2018; Şimşek, 2018). In this regards, Many studies have been carried out to reduce the capture of unwanted species during fishing operations (Şimşek and Demirci, 2016; Demirci and Ulaş, 2017; Ulaş et al., 2017; Şimşek, 2018; Şimşek and Demirci, 2018). However, nowadays there are catching of non-target catches in both recreational and commercial fishing (Pauly and Zeller, 2016; Zeller et al., 2018). The amount of these species is estimated to be 7 million tons (Kelleher, 2005). It has been reported that the discoloration of trawl fishing in Iskenderun Bay varies between 30% and 70% (Demirci, 2003). it was thought that these discarded species could survive depending on region, depth, duration, etc. (Saygu, 2011; Demirci et al., 2012; Şimşek, 2012; Saygu and Deval, 2014; Şimşek, 2018; Şimşek and Demirci, 2018).

Release of non-target species on board leads to some controversy between managers and researchers (Johnsen and Eliasen, 2011; Condie et al., 2014; Lloret et al., 2018; Karp et al., 2019). The European Union has started to implement a discard management plan, which will limit the release of sea creatures into the sea by identifying non-target catch composition (Damalas, 2015: Uhlmann et al., 2019). This implement does not want the discarded catch species into the sea after commercial fishing activities; instead, it is recommended that fishermen use more selective catching means. Although selective fishing gears have used in all fisheries, non-target catch will always be present, therefore, the live return of these discarded marine individuals to the sea seen as the most plausible method, especially fragile fish stock structures for species (Koslow et al., 2000; Mace, 2001; Gislason, 2003).

When considering the stress effect of the fishing operation on discarded fish species, it has necessary to reduce the effect as much as possible in the sea. Thus, the survival rates for many discarded fish species are over 50% (Şimşek, 2012; Demirci and Şimşek, 2018). However, for some fish species, additional applications are required especially for the demersal fish species with enlarged swim bladder (Şimşek and Demirci, 2018). These fish species passed quickly from the natural depth to the surface of the water. Therefore, these fish species have exposed to barotrauma.

Barotrauma is caused by the expansion of gas bubbles in the fish body due to the sudden pressure drop during the fishing operations. Depending on the severity of this trauma, bleeding in the internal organs of the body, the outflow of the eyes and pushing the stomach towards the mouth or even exiting for enlarged swim bladder. In this case even if a fish is released into the sea, it cannot move normally and cannot get deep and stays on the surface of the sea like a balloon (Uluç, 2014).

Barotrauma is intended to help fish return to normal swimming ability as soon as possible. Two methods have been used so far; (1) removal of excess gas pressure from the fish swim bladder and (2) releasing the external environment of the fish by re-pressurization by dipping.

In recent years, there have been some examples of application in the field of barotrauma treatment in fisheries (Şimşek, 2018). The most common and old method is to remove the gas y puncturing the fish from the outside of the swim bladder with a pointed needle. However, this application not only provides rapid recovery of the air sac of the fish but also does not produce the desired result in the eyes and other body cavities. In addition, it is suggested that a surgical application may cause secondary problems.

A hollow needle has the most commonly used method to sink into the swim bladder from the back muscles to expel the expanded gases, which are grown up as a result of the involuntary and rapid coming to the sea surface. This method was controversial because it was a surgical procedure and the achievements have been different from the species (Wilde, 2009). Moreover, the studies conducted by Campbell et al. 2014 and Wilde (2009) have formed discussions about the implementation of this method. Wilde (2009) argues that the potential for damaging organs and the likelihood of further tearing of the tissue associated with perforation from the edge of the fish are more severe than the positive effects. However, he showed that the death caused by the use of this method was low and suggested that there was a healing method (Wilson and Burns, 1996; Nguyen et al., 2009; McLennan et al., 2014).

Fish release devices are much more effective than venting needle because the only evacuation did not complete the gas in the fish-swimming bladder, and quickly returned the gases to the appropriate pressure levels (Butcher et al., 2012). Hyperbaric artificial recompression and field research, which form the basis of this method, has been shown to be more effective in the treatment of barotrauma symptoms (Roach et al., 2011; Pribyl et al., 2012; Drumhiller et al., 2014). The use of fish release devices eliminates the possibility of unwanted organ puncture and tissue damage in barotrauma treatment. These devices are generally composed of reverse basket, weighted clamp with clamp, grooved fishing rod or weighted cages with pressure increase. These methods are summarized, the fish placed in systems are reduced to the appropriate depth and they are provided to exit from these cages. In another way, the fish is lowered to the required depth by means of the grapple or needle from the chin section and this point also recovers the fish jaw that regains its ability to swim again (Stephensona et al., 2010; Demirci et al., 2013; Uluç, 2014; Brownscombe et al., 2017).

Iskenderun Bay has an important fishing area in the Mediterranean, where many commercial fishing methods take place. In addition, intensive recreational fishing activities have carried out in the region with angler fishing (Demirci and Arslantaş, 2018). In this region, the release of individuals in the form of barotrauma is necessary for both commercial fishing and recreational fishing activities on the sea. Depending on species diversity, there are a lot of unwanted species in the Iskenderun Bay fishery (Mavruk and Avşar, 2008).

White grouper *Epinephelus aeneus* and Dusky grouper *Epinephelus marginatus* which have been protected until 2020, are unintentionally caught in many fishing methods. It is a legal obligation to release these species into the sea after the fishing operation. However, these and other grouper species are deeply caught and most barotrauma when they come to the surface (Runde and Buckel, 2018). Due to the sudden pressure drop, barotrauma of these species shows the signs of swelling of the air sac, coming into the mouth and swelling of the eyeballs (Şimşek and Demirci, 2018). When a fish in this state is released to the sea, it cannot be immersed in water and cannot sustain its vitality (Demirci et al., 2013; Uluç, 2014).

In this study, three different release devices were analyzed by field trials and presented to fishermen. For these analyzes, the fish exposed to barotrauma releasing experiments were carried out with long line, hand line and trawl fishery in the Iskenderun Bay. At the end of this presentation and applications, fishingreturns were evaluated.

MATERIALS AND METHODS

In this study, release trails were made for Randall's threadfin bream, White grouper and Gold blotch grouper species with Fishing Release Hook (FRH) (Figure 1), Fish Release Clamp (FRC) (Figure 2) and Fish Release Basket (FRB) Figure 3.

FRH includes two systems for release more than one fish at the same time, by using hook or multiple hooks. The tool consists of two sections, which have a straight flexible, robust, curved hook and the main stem and lead weight. This tool components made of simple, cost-effective and easily available.

The FRC can be made of rigid plastic or metal products, a set of clamps on the main body, and the other part of this clamp is movable. These pincers were attached to the fish in the barotrauma by fish chins in the release deeper. The deeper layer weight required to squeeze the fish's chin was adjusted to the size of the fish.

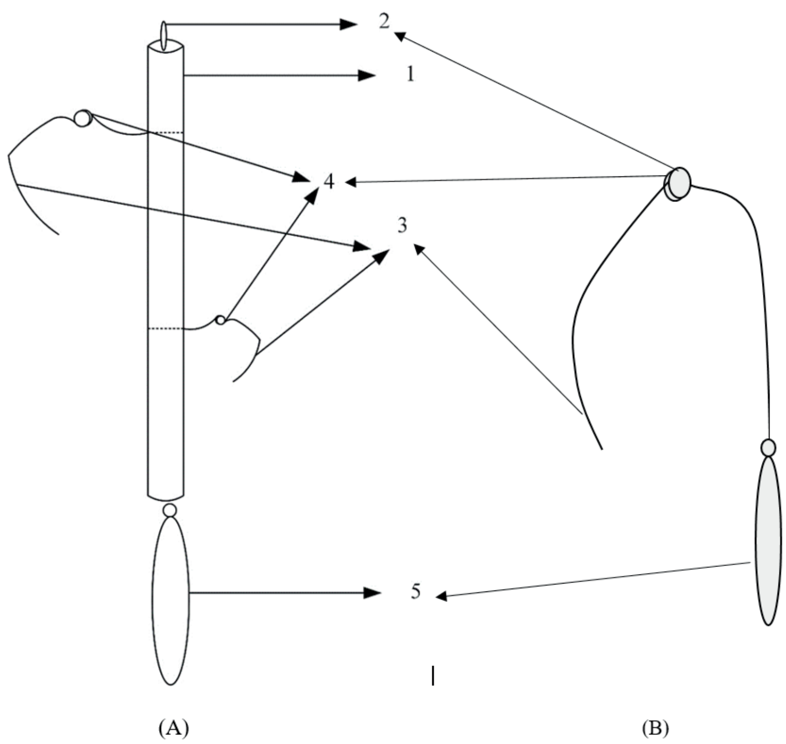

Figure 1. The Scheme of Fish Release Hook (FRH) (A: Use in releasing several fishes at the same time, B; Tool used in releasing a fish, 1: main body, 2: body-lashing ring, 3: needles of different size, 4: spring crimp, 5: lead)

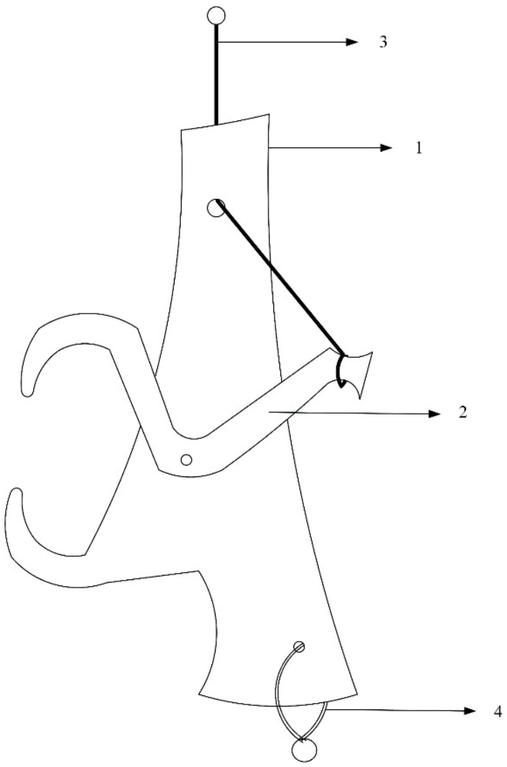

Figure 2. The Scheme of Fish Release Clamp (FRC) (1; main body, 2; movable clamp arm mounted on the main body, 3; steel rope, 4; lead)

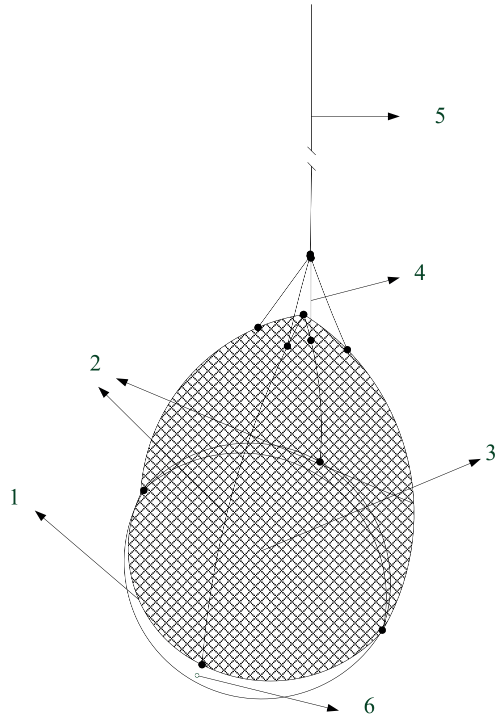

Figure 3. The Scheme of Fish Release Basket (FRB) (1; chrome steel frame, 2; connecting ropes, 3; part, 4; body connecting ropes, 5; main size, 6; extra weight for attaching holes)

The FRB, originally developed by nets as a mesh bag or fish bag, was dropped into the sea. It is important to select the mesh material, size and design, in order to prevent from damage fishes or escapees

It was tried to leave these fish in the form of barotrauma to a depth of 30 meters with this equipment after were caught fish by trawl, long line and hand line in the İskenderun Bay. Because, it is reported that the increase in the pressure at this depth of barotrauma treatment has rapid and effective results (Şimşek, 2018; Demirci et al., 2018; Şimşek and Demirci, 2018).

While the fishes were released with these devices, video recording with the underwater cameras were done during the operations on the ship. According to fish species and sizes, these records were evaluated and compared as a Positive and negative aspects at six points;

- Cost and feasibility of the team (C; Cost and Feasibility)
- Team portability on board (T; Transport)
- Attaching the release device to fish in barotrauma (F; Fitting)
- Hanging the fish from the boat to the water (RP; Releasing Procedures)
- Fish exposed to barotrauma immersing to depth (I; Immerse)
- Fish at the bottom of the water barotrauma recovered from the release device (FE; Fish Escaping)

RESULT AND DISCUSSION

Six attempts were made on the two sea expeditions in trawl fishing. In these experiments 30 individual of Randall's threadfin bream, 8 individual of white grouper and 12 individual of gold blotch groupers were successfully release to 28 meters deep with 30 FRBs, and all were recorded on video with in a healthy swim. The images of these release trials were shown in Figure 4. The FRB was not considered for the trawl-fishing vessel as the deck level of the ship was not suitable for its height above the sea surface.

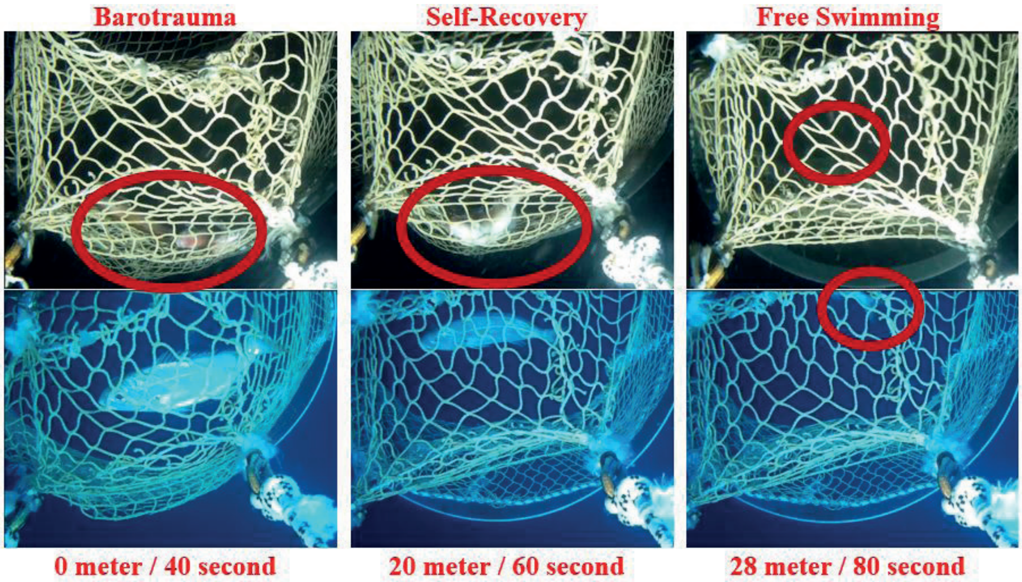

Figure 4. Images of the experimental of the white groupers and Randall's threadfin bream individuals with barotrauma after the trawl fishing with the FRB

Table 1. The FRB with different species and sizes in the form of barotrauma after trawl fishing

Fish Species	Number	Mean Length (cm)	Release Deeper (meter)	Release Hauling (second)	Result (%)
Randall's threadfin bream	30	15.05	28	100	100
White grouper	8	23.98	28	120	100
Gold blotch grouper	12	20.68	28	120	100

FRH and FRC experimental releasing were conducted in the fish caught by long line and the hand line. In these FRH trials, 10 individual of Randall's threadfin bream, 5 individual of white grouper and 6 individual of gold blotch grouper were releasing, while in FRC trials 12 individual of Randall's threadfin bream, 4 individual of white grouper and 5 individual of gold blotch grouper were releasing in the dip sea (30 m). It was not possible to get rid of the fish fishing with FRH. However, when the lead weight was used more with the FRC, the fish could not be recovered from the device even though the fish body form had recovered from barotrauma. In this unfavorable case, the fish sample was back to the surface again when it returned to the devices. Therefore; it was concluded that appropriate weight selection is required for fish species and size when using FRC for barotrauma fish releasing. In these FRC trials, it was found that a maximum weight of half kg was sufficient for the evaluation between the fish size and the release weight. Results of FRC is given in Table 3. The maximum released fish weight in these trials is 700 g, in this context: the weight of the fish should be more than half weight of the fish, but not exceed the weight of the fish. In other words, it is not possible to get rid of 500 g lead weight, which is widely used for 200 g fish. The appearance of White grouper and Gold blotch grouper during releasing with FRC is given in Figure 5 and Figure 6, respectively.

Another point to be considered in the use of FRC is the fish was attached to the devices. In this study, claws were attached to the upper and lower chin. Attachment of the chin to the uppers gave more positive results than the lover chin. Other important considerations were the sharpness and suitability of the size of the clamp to the fish mouth.

Figure 5. Release of the white grouper in the form of barotravma deeper, recovery and self-recovery of fish (a: Lowering, b: Barotrauma recovery, c: rescue effort and d: rescue)

Table 2. The FRH with different species and sizes in the form of barotrauma after the longline and hand line fishing

Number	Species	Length (cm)	Release Depth (meter)	Release Hauling (second)	Result
1	Randall's threadfin bream	17.6	20	135	+
2		15.4	18	140	+
3		18.1	25	155	+
4		12.3	20	210	+
5		10.8	16	150	+
6		14.8	22	145	+
7		13.9	25	150	+
8		18.4	28	170	+
9		16.2	28	125	+
10		11.7	18	150	+
11	White grou-per	19.6	25	125	+
12		15.4	25	90	+
13		22.9	25	75	+
14		28.2	35	70	+
15		24,8	30	70	+
16	Gold blotch grouper	18.4	25	100	+
17		16.3	25	90	+
18		17.5	20	90	+
19		18.2	25	85	+
20		17.9	25	90	+
21		18.8	20	60	+

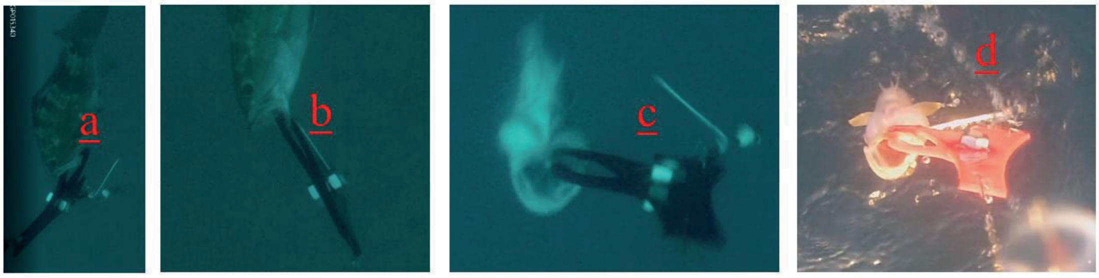

Figure 6. Images of Gold blotch groupers with the release clamp to the bottom in the form of barotrauma, the recovery and recovery of the fish itself cannot recover from the clamp (a: immerse, b: barotravma recovery, c: escape effort and d: return to the surface)

Table 3. The FRC with different species and sizes in the form of barotrauma after the longline and hand line fishing

Number	Fish Species	Length (cm)	Release Depth (meter)	Release Hauling (second)	Result
1	Randall's threadfin bream	15.2	30	-	-
2		13.7	18	140	+
3		15.8	25	155	+
4		14.2	32	210	+
5		12.9	16	150	+
6		16.1	24	145	+
7		12.4	25	150	+
8		13.5	28	170	+
9		13.6	28	125	+
10		16.8	25	150	+
11		17.5	23	135	+
12		16.4	22	120	+
13	White grouper	19.7	35	125	+
14		16.9	25	90	-
15		18.4	25	75	+
16		18.3	25	70	+
17	Gold blotch grouper	15.5	25	100	-
18		16.4	25	90	+
19		15.9	20	90	+
20		18.2	25	85	+
21		17.6	25	90	+

There is no scientific study related on fish release device. Therefore, a comparative evaluation could not be made. There is only one field study on commercial longline fishery in the Eastern Mediterranean (Gökçe et al., 2018). In this study, Grouper species were dropped to the bottom with fish release hooks.

As a result of this study, the obtained performances of the fish release devices are shown in Figure 7. In this figure, a scale from red to blue was created because of the more comprehensible. The red color on this scale represents the negative state while the blue represents the positive state. In this assessment, fish release devices were considered into five issues. While the FRB was negative in terms of cost and move, the use of FRC and FRH requires experience. it can also be said that the use of FRB is suitable for bottom trawl fishing, while the use of FRH and FRC is more ergonomic in longline and hand line fishery.

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	FRB	FRC	FRH
C	Connecting ropes requires experience. If the diverter frame can chose to be stainless, the cost increases.	The material must be prepared from a hard material. Requires experience and knowledge.	Low cost and easy to supply.
T	Difficult to transport on small ships due to the size.	Easy	Easy
F	Easy	Requires experience	Requires experience easy than other.
RP	Requires experience. However, more than one fish can be release at the same time.	It is necessary to adjust the clamp mouth and weight according to the size of the fish.	Due to the height of the ship deck, the fish may fall from the needle without entering the water. Needle length and suspension distance must be set.
I	Fish cannot be damaged.	The speed must be checked. It is very fast when the fish is injured or the desired depth before it comes out.	The speed must be checked. Injury of the fish when it is too fast.
FE	Easy escaping	If the weight is too much, it is very difficult.	The ability of the fish to swim and the length of the needle require a wait. However, when the devices is lifting, the fish is easy escaping.
Color scale			
Positive			Negative

Figure 7. The analyzes with use of different release devices for barotrauma fish (**C;** Cost and Feasibility, **T;** Transport, **F;** Fitting, **RP;** Releasing Procedures, **I;** Immerse, **FE;** Fish Escaping)

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