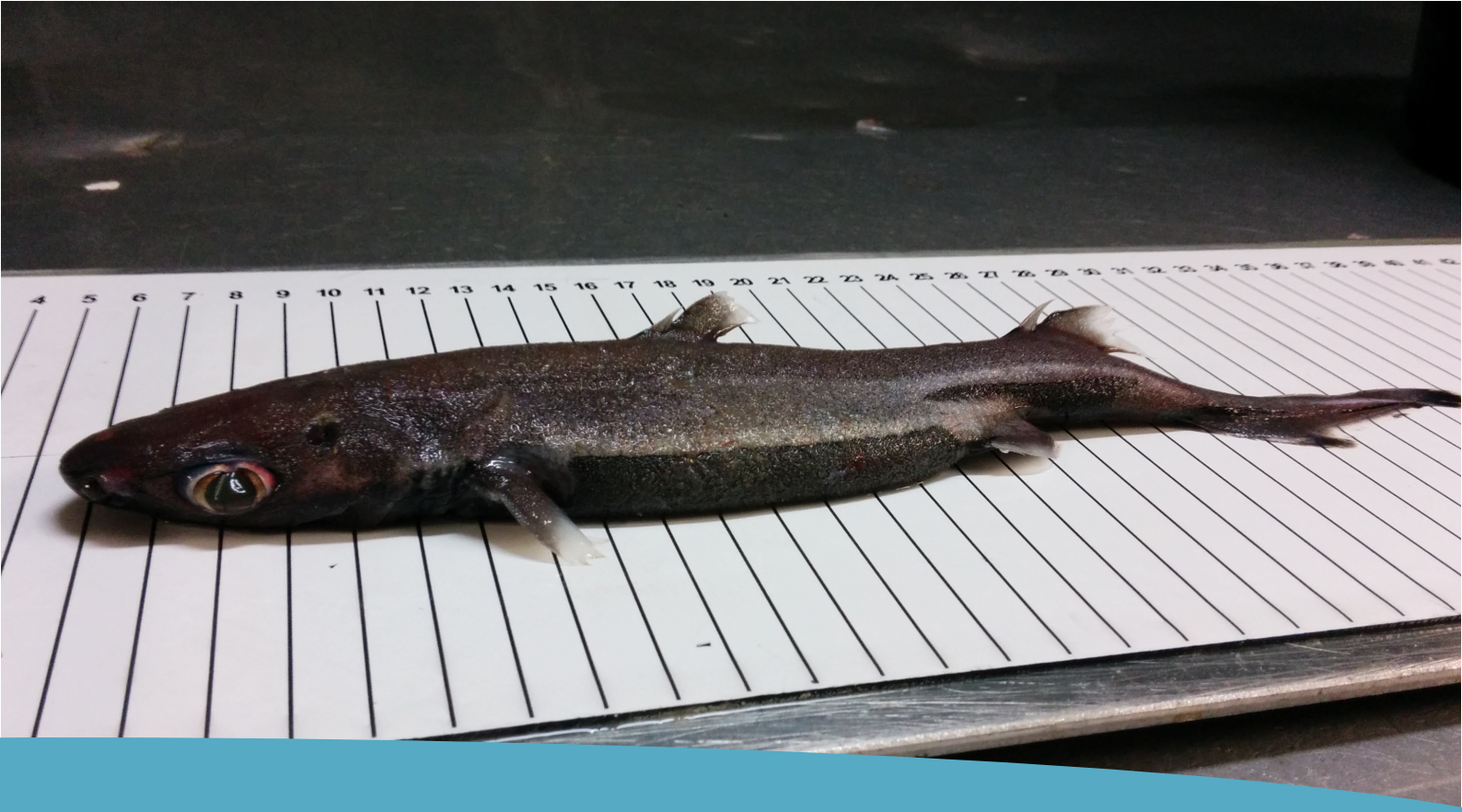

Aqua reports 2022:3

Tekniska lösningar för att undvika oönskad fångst av broskfisk

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Finansiär:
Havs- och vattenmyndigheten, Dnr 2687-2021

Rapporten har tagits fram på uppdrag av Havs- och vattenmyndigheten. Rapportförfattarna ansvarar för innehållet och slutsatserna i rapporten. Rapportens innehåll innebär inte något ställningstagande från Havs- och vattenmyndighetens sida.

Publikationsansvarig:	Noél Holmgren, Sveriges lantbruksuniversitet (SLU), Institutionen för akvatiska resurser
Utgivare:	Sveriges lantbruksuniversitet (SLU), Institutionen för akvatiska resurser
Utgivningsår:	2022
Utgivningsort:	Lysekil
Illustrationer:	Blåkäxa *(Etmopterus spinax)* fångad i räkfisket med bottentrål. Foto: Mikael Ovegård
Serietitel:	Aqua reports
Delnummer i serien:	2022:3
ISBN:	978-91-576-9947-3 (elektronisk version)
Nyckelord:	Broskfisk, bifångst, yrkesfiske, redskapsutveckling

Sammanfattning

Den här rapporten sammanställer nuvarande kunskapsläge gällande tekniska lösningar som syftar till att minska oönskad fångst av broskfisk i fiskeredskap. Fokus för rapporten är tekniska lösningar som baseras på broskfiskarnas specifika sinnesorgan och beteenden, samt de fiskeredskap som används inom det svenska yrkesfisket.

En systematisk genomgång av vetenskapliga publikationer, avhandlingar och tekniska rapporter utfördes via The Bycatch Management Information System, Web of Science och Google Scholar. Sökning efter litteratur på dessa websidor utfördes med kombinationer av de engelska sökorden; *Bycatch*, *mitigation*, *deterrents*, *reduction*, *sharks*, *rays* och *skates*, och begränsades till litteratur som publicerats mellan år 2010 och 2021. Utifrån resultatet av sökningarna bedömdes totalt 47 publikationer som relevanta för sammanställningen (9 sammanfattningar och 38 originalpublikationer). Originalpublikationerna katalogiserades i referensbiblioteket Zotero enligt typ av testad stimuli för påverkan på beteende (kemiskt, akustiskt, visuellt, elektromagnetiskt), vilken typ av fiske studien riktade sig mot (trål, garn, krok, bur), typ av experiment som utförts (fältförsök eller i fångenskap), och resultat av studien. Publikationer där testat stimuli gav önskat resultat katalogiserades som "Positiv", publikationer där resultaten var begränsade till en av flera testade arter alternativt en av flera testade lokaler katalogiserades som "Begränsad", publikationer där testad stimuli inte gav önskad effekt på beteende katalogiserades som "Negativ".

Resultatet från litteraturstudien visade att det för närvarande inte finns en uppenbar generell teknisk lösning, baserad på broskfiskarnas specifika sinnesorgan och beteende, som skulle kunna användas för att minska mängden oönskad fångst av broskfisk i det svenska yrkesfisket. Den repellerande effekten på fisken som de tekniska lösningarna som analyserades avsåg att skapa, visade sig i samtliga fall endast fungera bara för vissa arter eller under vissa förutsättningar. Givet detta, nuvarande läge i utbredning och abundans av broskfisk i svenska vatten samt oönskade fångster av dessa, så är den åtgärd som sannolikt skulle ge störst positiv effekt för bestånden, istället ett utökat användande av rist i fisket med trål.

Abstract

This report summarizes current knowledge regarding technical mitigation measures aiming to reduce unwanted catches of elasmobranchs in fishing gears. The focus of the report is technical measures that are based on elasmobranchs specific sensory organs and behaviour, and fishing gears that are used in the Swedish commercial fishery.

A systematic review of scientific publications, theses and technical reports was conducted via The Bycatch Management Information System, Web of Science and Google Scholar. Search for literature on these websites was conducted with combinations of the keywords; *Bycatch*, *mitigation*, *deterrents*, *reduction*, *sharks*, *rays* and *skates*, and limited to literature published between 2010 and 2021. A total of 47 publications were found to be relevant from the perspective of "technical mitigation" (9 reviews and 38 publications of original research). The publications covering original research were catalogued in the Zotero reference library according to the type of stimuli tested for effect on behaviour (chemical, acoustic, visual, electromagnetic), the type of fishery the study targeted (trawl, net, hook, pot), type of experiment performed (field experiment or captivity), and results of the study. Publications where the tested stimuli gave the desired result were catalogued as "Positive", publications where the results were limited to one of several tested species or one of several tested locations were catalogued as "Limited", publications where the tested stimuli did not give the desired effect on behaviour were catalogued as "Negative".

The results from the literature study showed that there is currently no general technical mitigation measure, based on the elasmobranchs specific sensory organs and behaviour, which could be used to reduce the amount of unwanted catch of elasmobranchs in the Swedish commercial fishery. The repellent effect on the fish that the technical measures intended to create, proved in all cases to be only effective for certain species or under certain conditions. Given this, the current situation in the distribution and abundance of elasmobranchs in Swedish waters and unwanted catches of these, the measure that would likely have the greatest positive effect on the stocks is, instead, an increased use of grid in fisheries using trawl.

Innehållsförteckning

1. Bakgrund

Broskfiskar (Chondrichthyes) indelas vanligtvis i underklasserna hajartade fiskar (Elasmobranchii) och helhuvudfiskar (Holocephali). Den sistnämnda innehåller bara en nu levande ordning, vilket är havsmusartade fiskar (Chimaeriformes). Totalt omfattar broskfiskar cirka 1200 nu levande arter av hajar och rockor, och 56 havsmusartade fiskar (Roskov m. fl. 2021). Gemensamt för klassen är att de har ett skelett bestående av brosk, saknar simblåsa och har inre befruktning (Nelson m. fl. 2016). Som grupp betraktat har broskfiskarna långsam tillväxt, sen könsmognad, lång livslängd och låg naturlig dödlighet samtidigt som de producerar få och stora avkommor (Stenberg m. fl. 2015). Kombinationen av dessa egenskaper gör dem känsliga för fiske och innebär att det även tar lång tid innan ett bestånd av broskfiskar kan tänkas svara positivt på förvaltningsåtgärder så som minskad fiskeridödlighet. Har det fiskade beståndet minskat kraftigt kan återhämtningstiden därför i bästa fall bli mycket lång, och i sämsta fall utebli helt. Då de flesta broskfiskar tillhör kategorin toppredatorer så har de en viktig roll i den marina näringsväven. Utfiskning av dessa arter riskerar att leda till storskaliga ekosystemförändringar med förändrade fisksamhällen som följd. När betydande förändringar i fisksamhället skett kan det vara mycket svårt att återgå till ett tidigare önskvärt tillstånd (Stevens m. fl. 2000).

I Sverige finns broskfiskar uteslutande i marin miljö, och i stort sett bara i Skagerrak och Kattegatt. Endast ett fåtal observationer har gjorts i Östersjön (SLU Artdatabanken 2021). Av de hajartade fiskarna är det bara blåkäxa (*Etmopterus spinax*), gråhaj (*Galeorhinus galeus*), håbrand (*Lamna nasus*), håkäring (*Somniosus microcephalus*), pigghaj (Squalus acanthias), småfläckig rödhaj (*Scyliorhinus canicula*), klorocka (*Amblyraja radiata*), knaggrocka (*Raja clavata*) och vitrocka (*Dipturus linteus*) som förekommer regelbundet i svenska vatten (SLU Artdatabanken 2021). Gällnade de havsmusartade fiskarna så finns det endas en art i svenska vatten, havsmus (*Chimaera monstrosa*; SLU Artdatabanken 2021). Undantaget småfläckig rödhaj så är samtliga bestånd av broskfisk som förekommer i svenska vatten klassade som nära hotade, starkt hotade eller akut hotade enligt den svenska rödlistan (Eide m. fl. 2020).

För att skydda och bevara broskfiskarna är fisket på de bestånd som finns i svenska vatten reglerade genom EU- och nationell lagstiftning (förordning (EU) 2021/92;

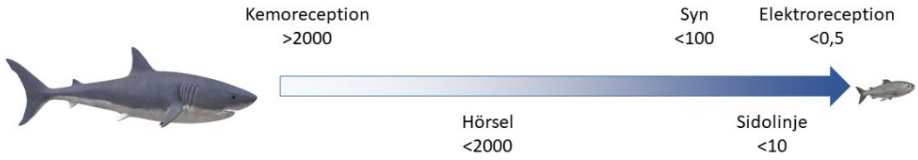
FIFS 2004:36). Den av EU beslutade totalt tillåtna fångstmängden (TAC) för rockor (alla arter tillsammans) är 11 ton i Skagerrak och Kattegatt för 2022, varav Sveriges kvot är 3 ton. TAC:n är dock preliminär och är, likt för de många andra bestånd, tills vidare satt till 25 % av 2021-års TAC i avvaktan på slutliga överenskommelser med övriga intressenter (UK, Norge m. fl. länder). TAC:n 2021 för rockor i Skagerrak var alltså 45 ton varav Sveriges kvot var 10 ton (Regulation (EU) 2021/92), och sannolikt kommer samma tillåtna fångstmängd gälla även under 2022. Under nuvarande reglering sker det inget riktat yrkesfiske på någon art av broskfisk i svenska vatten, dock sker bifångst av broskfisk i yrkesfisket som riktar sig mot andra arter (Börjesson m. fl. 2022). Av dessa bifångster är det bara vitrocka som sporadiskt landas i en mindre kvantitet, medan övriga arter av broskfisk som fångas i svenska vatten är antingen fredade eller utan kommersiellt värde. De arter som är fredade får inte skadas av fisket och ska omedelbart återutsättas om de fångas. Genom ett undantag från landningsskyldigheten (artikel 15 i förordning (EU) nr 1380/2013), får dessutom oönskad fångst av icke fredade arter av rockor återutsättas då de bedöms ha hög överlevnad. Avsaknaden av simblåsa har den fördelen att broskfisk som dras upp från stort djup inte riskerar att sprängas likt fisk med simblåsa, och chanserna att de överlever vid en återutsättning anses därför generellt goda (Braccini m. fl. 2012). Överlevanden hos broskfiskar som återutsätts är dock beroende av både art och fångstmetod (Oliver m. fl. 2015). Hur stor överlevnaden är för de arter av broskfisk som fångas och återutsätts i svenskt fiske är inte klarlagt.

Det finns idag inga tekniska regleringar inom det svenska yrkesfisket som syftar specifikt till att minska mängden oönskad fångst av broskfisk. De redskapsregler som finns, gällande användandet av olika maskstorlekar eller separering av fångst via rist och/eller flyktöppningar, är generellt utformade för att sortera ut demersal rundfisk genom storleksselektion snarare än riktad artspecifik selektion. Även om vissa av dessa tekniska lösningar, som t.ex. rist i en räktrål, benämns som artselektiva (för att de separerar ut räkan från större fisk), så är denna artseparering i huvudsak en effekt av att fisken är av större storlek än räkan och inte på grund av att fisken förväntas ha ett annat beteende än räkan baserat på egenskaperna hos fångstredskapet.

Broskfiskar har vissa egenskaper som skiljer dem från de flesta andra arter av marina organismer. Utöver syn, hörsel, kemoreception (luktsinne) och känsel så använder broskfiskar även ett sidolinjeorgan och elektroreceptorer för att inhämta information om sin omgivning (Figur 1). Sidolinjeorganet, som även finns hos andra grupper av fiskar och vissa kräldjur, består av en kanal med små öppningar i form av nålstora porer utmed fisken sida. I kanalen finns små sinneshår, då tryckvågor passerar genom kanalen förändras hårens placering och transmittorsubstanser skickas till nervsystemet (Webb m. fl. 2008).

Sidolinjeorganet påminner därmed mycket om örats uppbyggnad och funktion, fisken kan ”höra” tryckförändringar i vattnet med hjälp av sidolinjeorganet. Broskfiskarnas elektorreceptorer, som kallas lorenzinska ampuller, är ett unikt organ för denna grupp av fiskar. De lorenzinska ampullerna består av rör med elektriskt isolerande väggar och innehåller ett elektriskt ledande slem. Ampullerna mynnar via lorenzinska kanaler som slemporer på kroppsytan. Slemporerna är spridda på ytan, men inne i fisken konvergerar rören och samlas i några få, begränsade områden. Där rören slutar inne i fisken finns själva sinnescellerna, och dessa reagerar på elektriska potentialer och mäter den elektriska spänningen mellan slemporen och fiskens inre potential. Genom att kanalerna är långa och orienterade åt olika håll kan riktning mot källan och mycket svaga elektromagnetiska fält uppfattas. Beteendeförsök har visat att en rocka kunde reagera på 5 nV/cm, motsvarande 1 volt på en sträcka av 200 mil. Broskfiskar kan därmed upptäcka osynliga byten, t.ex. nedgrävda plattfiskar, på några decimeters avstånd genom de elektriska fält dessa ger ifrån sig. (Kullander m. fl. 2011).

Broskfiskars reaktion på fysiska och kemiska stimuli nyttjas globalt i en mängd olika sammanhang för att påverka deras beteende. Syftet med denna rapport är att sammanställa befintliga tekniska lösningar, som syftar till att reducera interaktion med och fångst av broskfisk i fiskeredskap, baserat på broskfiskarnas specifika sinnesorgan och beteende. Utifrån detta kunskapsunderlag presenteras även rekommendationer på vilka tekniska lösningar som potentiellt skulle kunna användas för att undvika oönskad fångst av broskfisk i svenskt yrkesfiske.



Figur 1. Schematisk presentation över vid vilka avstånd (i meter) broskfiskars olika sinnen stimuleras av ett mål, som t.ex. ett byte. Avstånden baseras på bästa tänkta förhållanden, verkliga avstånd varierar med abiotiska förhållanden och mellan olika arter (Jordan m. fl. 2013).

2. Metod

För att sammanställa nuvarande kunskap gällande tekniska lösningar som syftar till att reducera fångsten av broskfisk i fiskeredskap utfördes en litteraturstudie. En systematisk genomgång av vetenskapliga publikationer, avhandlingar och tekniska rapporter utfördes via The Bycatch Management Information System (BMIS) (https://www.bmis-bycatch.org), Web of Science (WoS) (https://www.webofscience.com) och Google Scholar (GS) (https://scholar.google.com/). Samtliga av dessa websidor tillhandahåller sökmotorer som genererar listor med länkar till publicerat material och/eller tidsbeständiga identifieringsnummer (DOI). BMIS är, som namnat antyder, anpassad specifikt för information relaterat till bifångst inom fiske. WoS är en citeringsdatabas där publikationer från majoriteten av alla värdens vetenskapliga tidskrifter indexeras. För närvarande innehåller denna databas över 155 miljoner sökbara publikationer i Core Collection™ (Clarivate 2021). GS är en fritt tillgänglig sökmotor riktad mot vetenskapliga publikationer som likt Googles normala sökmotor medger textsökning från alla delar av dokument som är tillgängliga på internet. Sökning efter litteratur på dessa websidor genomfördes med kombinationer av de engelska sökorden; *Bycatch*, *mitigation*, *deterrents*, *reduction*, *sharks*, *rays* och *skates*, och begränsades till litteratur som publicerats mellan år 2010 och 2021. Sökningarna genererade totalt 872 träffar. Av dessa träffar granskades samtliga från BMIS (49) och WoS (92) för relevans. Av de 731 träffarna som genererades av GS sökmotor granskades de första 100 sökresultaten för relevans. Eftersom resultaten från GS sorterades utifrån antal träffar av nyckelorden i hela dokumenttexten och citeringsgrad, så bedömdes de träffar som kom efter 100 i resultatlistan inte kunna bidra ytterligare till sammanställningen (totalt var det endast ett fåtal av de 100 första träffarna som bidrog med något utöver de publikationer som redan insamlats via BMIS och WoS). Under genomgången av träffarna sorterades 47 publikationer ut som relevanta ur perspektivet ”tekniska lösningar” baserat på innehållet i dess sammanfattning (abstract). Resterande publikationer behandlade framförallt övriga förvaltningsåtgärder (så som fredade områden), fångst av andra djurgrupper (reptiler, fåglar, marina däggdjur), och olika typer av sammanställningar av mängden fångst av broskfisk och effekten av detta på ekosystemen. Av de 47 publikationer som bedömdes relevanta så var 9

sammanfattande publikationer (Appendix 1) och 38 publikationer i form av originalartiklar (Appendix 2).

Originalartiklar katalogiserades i referensbiblioteket Zotero (https://www.zotero.org/) enligt typ av stimuli (kemiskt, akustiskt, visuellt, elektromagnetiskt) som användes i studien, vilken typ av fiskeredskap studien riktade sig mot (trål, garn, krok, bur), typ av experiment som utförts (fältförsök eller fångenskap), och resultatet av studien. Publikationer där testat stimuli gav önskat resultat katalogiserades som "Positiv", publikationer där resultaten var begränsade till en av flera testade arter alternativt en av flera testade lokaler katalogiserades som "Begränsad", publikationer där testad stimuli inte gav önskad effekt på beteende katalogiserades som "Negativ".

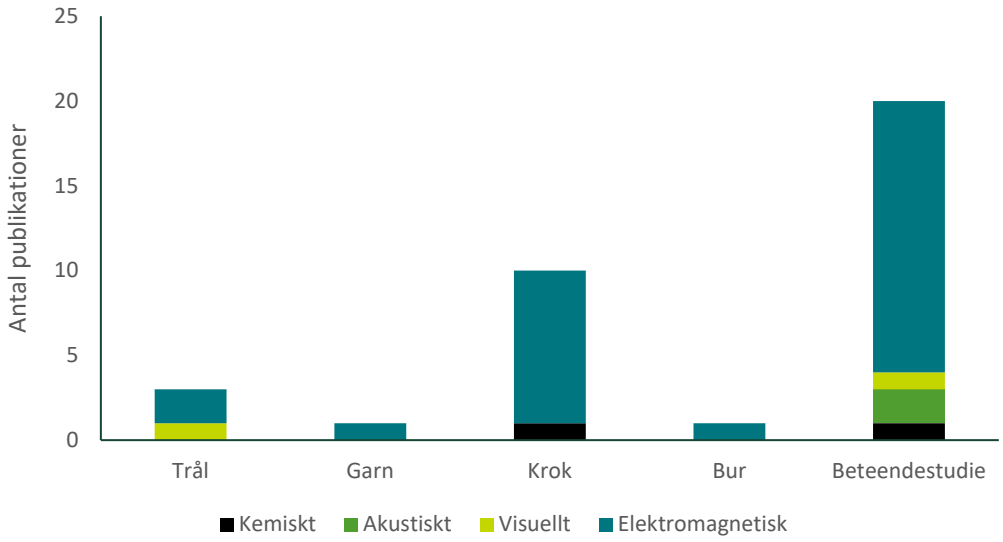
Originalartiklar som handlade om rist i trål fick en egen kategori, och försök som inte relaterade till en viss typ av fiskeredskap kategoriserades som beteendestudie. Eftersom litteraturgenomgången gav få eller inga exempel på tekniska lösningar som syftar till att reducera oönskade fångster i övriga typer av fiskeredskap som används inom svenskt yrkesfiske (så som ringnot, snurrevad, fällor och ryssjor), samt att där fanns lite eller ingen kunskap om omfattningen av oönskad fångst av broskfisk i dessa redskap (Bergenius m. fl. 2018), så exkluderades dessa från sammanställningen som presenteras i denna rapport. Utifrån katalogiseringen som beskrivs ovan, genomfördes även en analys över vilken typ av stimuli som testats, vilka stimuli som påverkat ett beteende, och under vilka förutsättningar detta inträffat.

3. Resultat

Katalogiseringen visade att forskning kring lösningar för att minska fångst av broskfisk under de senaste 10 åren i hög grad varit fokuserad på krokfiske och elektromagnetiska stimuli (Tabell 1, Figur 2). Detta resultat är i linje med de sammanställningar som presenteras i de sammanfattande publikationerna (Appendix 1). Krokfisket, efter framförallt tonfisk, har ur ett globalt perspektiv omfattande problem med oönskade fångster av broskfisk och har av denna anledning varit fokusområde för forskningen kring reduktion av fångst av broskfisk även före 2010. Där finns emellertid ett antal studier som även riktar sig till andra typer av fiskeredskap och/eller generella effekter av olika stimuli på broskfisk. Nedan följer en sammanfattning över identifierade tekniska lösningar, grupperat per typ av stimuli, som har potential att påverka broskfiskars beteende. För- och nackdelar utifrån metodens applicerbarhet i svenskt yrkesfiske listas.

Tabell 1. Antal originalartiklar per typ av stimuli som ingick i litteraturstudien (publikationer rörande rist i trål exkluderade, vilket ger totalt 36 publikationer i tabellen). "Fiske" anger vilken typ av fiskeredskap studien riktade sig mot. Försök som inte relaterade till en viss typ av fiskeredskap kategoriserades som beteendestudie. "Försök" anger om studien utfördes i fält eller med fisk i fångenskap. Publikationer där testat stimuli gav önskat resultat anges som "Positiv" (Pos), publikationer där resultaten var begränsade till en av flera testade arter alternativt en av flera testade lokaler anges som "Begränsad" (Beg), publikationer där testad stimuli inte gav önskad effekt på beteende anges som "Negativ" (Neg).

Stimuli	Fiske	Försök	Pos	Beg	Neg
Kemiskt	Krok	Fält	0	0	1
Kemiskt	Beteendestudie	Fält	1	0	0
Akustiskt	Beteendestudie	Fält	0	2	0
Visuellt	Trål	Fält	0	1	0
Visuellt	Beteendestudie	Fångenskap	0	1	0
Elektromagnetisk	Trål	Fångenskap	0	1	1
Elektromagnetisk	Garn	Fält	1	0	0
Elektromagnetisk	Krok	Fält	0	4	4
Elektromagnetisk	Krok	Fångenskap	0	0	1
Elektromagnetisk	Bur	Fält	1	0	0
Elektromagnetisk	Beteendestudie	Fält	2	6	1
Elektromagnetisk	Beteendestudie	Fångenskap	2	4	1



Figur 2. Antal publikationer av originalartiklar per stimuli grupperat per redskapstyp som ingick i litteraturstudien (publikationer rörande rist i trål exkluderade, vilket ger totalt 36 publikationer i figuren). Beteendestudie representerar publikationer som inte riktade sig mot ett specifikt fiskeredskap.

3.1. Kemiska substanser

Forskning som syftar till att finna en kemisk substans som avskräcker broskfisk har pågått sen 1940-talet. Under senare delen av andra världskriget och ett årtionde därefter bedrev till exempel den amerikanska och australienska flottans forskningslaboratorier intensiva försök för att finna en kemisk substans som skulle kunna släppas ut i vattnet för att skydda människor från hajangrepp. Hundratals olika ämnen, flera av dem mycket giftiga, har testats under både kontrollerade förhållanden i laboratorier och under fältförsök. Då ingen av de kemiska föreningarna som testades kunde bevisas vara effektiva över tid, övergavs denna idé under 1970-talet (Hart och Collin 2015). På senare tid (2000-talet) har forskningen tagits upp igen, men då riktad mot icke giftiga semiokemikalier (kemiska signalämnen som har specifik betydelse för mottagaren så som t.ex. feromoner). Försök med semiokemikalier baserat på ruttnade hajkött (så kallade necromoner) visade sig ha avskräckande effekt på karibiska revhajar under en beteendestudie av Stroud m. fl. (2014). Ruttnade hajkött visade sig dock inte reducera fångsterna av broskfisk då det testades i krokfisket av Broadhurst och Tolhurst (2021). Idag finns det företag som utvecklar produkter för reducering av oönskad fångst av broskfisk baserat på semiokemikalier (t.ex. http://www.sharkdefense.com/). Produkten ”Super Poly Shark”, som är en syntetisk semiokemikalie utvecklad specifikt för att undvika fångst av hajar i krokfisket, kom på andra plats under WWF:s ”International Smart Gear

Competition 2014" (WWF 2015). Den här tekniska lösningen består av en mindre cylinderformad pellet som placeras tillsammans med betet på kroken. Pelleten löses sakta upp i kontakt med vatten och släpper under tiden ut semiokemikalier. Efter ca 16 h är pelleten förbrukad. Enligt tillverkaren kan Super Poly Shark minska fångsten av haj i krokfisket med 71 %, utan att påverka fångsten av målart negativt. Denna produkt finns dock inte kommersiellt tillgänglig för närvarande och det finns ännu ingen oberoende studie som visar att den fungerar så som tillverkaren hävdar (Sacchi 2021). Utöver utmaningen att hitta en kemisk substans som inte är giftig men samtidigt effektiv vid extremt låga koncentrationer, vilket är nödvändigt om det ska fungera då den späds ut i havet, så är det även praktiskt mycket svårt att sprida en kemisk substans kontrollerat i en dynamisk havsmiljö (Connell m. fl. 2014).

Fördelar med kemiska substanser:

- Potentiellt applicerbara i både aktiva (t.ex. trål) och passiva (t.ex. krok, garn och bur) redskap.
- Kan teoretiskt avskräcka broskfisk på långt avstånd.
- Eventuellt låg tillverkningskostnad vilket gör metoden relativt billig att använda för fiskaren.

Nackdelar med kemiska substanser:

- Saknar bevisad effekt gällande reduktion av oönskad fångst av broskfisk i fiskeredskap.
- Effektiviteten av metoden och spridningen av substanserna påverkas av vattnets rörelse och beskaffenhet i form av strömmar och skiktningar.
- Det är okänt hur de kemiska substanserna som används påverkar andra arter och ekosystemet som helhet.

3.2. Akustiska signaler

Där finns få publicerade resultat från forskning kring broskfiskars reaktion på akustiska signaler. Chapuis och medförfattare hävdar i sin publikation från 2019 (Cahpuis m. fl. 2019) att deras studie av hur hajar reagerar på två olika typer av ljudstimuli är den första i sitt slag sen 1970-talet. Man studerade hur åtta olika arter av frilevande hajar (sju arter av rev- och kusthajar, samt vithaj (*Carcharodon carcharias*)) reagerade på inspelat ljud från späckhuggare (som är en predator på de sju arterna av rev- och kusthajar) samt ett artificiellt ljud. Rev- och kusthajarna uppvisade ett till viss del undvikande beteende gentemot båda typerna av

ljudstimuli, medan vithajarna inte avskräcktes av ljud från späckhuggare. Vithajarna visade dock ett visst avvikande beteende gentemot det artificiella ljudet. Författarna till denna studie konstaterar att ljud i sig inte är tillräckligt avskräckande för att det ska kunna användas för att helt begränsa interaktionen med hajar. I en annan studie undersökte Ryan m. fl (2017) hur port jacksonhaj (*Heterodontus portusjacksoni*) och epåletthaj (*Hemiscyllium ocellatum*) i fångenskap, samt frilevande vithajar, reagerade på ljud i kombination med blinkande strobljus. Resultaten från studien visade på ett undvikande beteende hos hajarna i fångenskap då ljus eller då både ljus och ljud används, men ingen skillnad i beteende kunde påvisas då endast ljud användes för någon av arterna. Utifrån de sammanfattande publikationerna (Hart och Collin 2015; Sacchi 2021), så finns det idag endast en enda kommersiell produkt som använder sig av akustiska signaler i syfte att avskräcka haj. ”Sharkstopper®” (http://www.sharkstopper.com/), finns både som en mindre enhet för ”personskydd” och en större enhet för att avskräcka hajar på längre avstånd. Produkten, som består av en undervattenshögtalare kopplad till en basenhet med energikälla och förstärkare, sänder ut ljudpulser inom frekvensbanden 30 – 500 Hz och 200 – 1500 Hz (späckhuggarefrekvenser). Produkten ska enligt tillverkaren avskräcka ett flertal arter av haj, bland annat pigghaj. Det finns dock ännu ingen oberoende studie som visar att denna produkt fungerar så som tillverkaren hävdar. Utifrån tillgänglig information som använts för denna rapport har akustiska signaler inte testats för att reducera fångst av broskfisk i fiskeredskap. Antropogena ljudföroreningar i haven är ett växande problem och har en allt större negativ effekt ekosystemen (Solan 2016). En eventuell utveckling av en teknisk lösning för reduktion av oönskad fångst av broskfisk, som bidrar till ytterligare ljudföroreningar i haven, måste därför vägas mot skadan en sådan produkt kan göra på ekosystemet som helhet.

Fördelar med akustiska signaler:

- Potentiellt applicerbara i både aktiva (t.ex. trål) och passiva (t.ex. krok, garn och bur) redskap.
- Kan teoretiskt avskräcka broskfisk på långt avstånd.
- Kommersiellt tillgänglig produkt som tillverkaren hävdar har avskräckande effekt på pigghaj.

Nackdelar med akustiska signaler:

- Saknar bevisad effekt gällande reduktion av oönskad fångst av broskfisk i fiskeredskap.
- Användning av ljud i större skala kan påverka övriga delar av ekosystemet negativt.

- Tekniskt komplex lösning som kräver extern energikälla och elektronik med hög kapslingsklass.

3.3. Visuella signaler

Likt akustiska signaler så finns få studier som utvädrat effekten av ljussignaler på broskfiskars beteende. Som nämnts i avsnittet ovan, undersökte Ryan m. fl (2017) hur port jacksonhaj och epåletthaj i fångenskap, samt frilevande vithajar, reagerade på ljud i kombination med blinkande strobljus. Resultaten från studien visade att strobljus minskade antalet tillfällen hajarna i fångenskap tog ett bete, men det hade ingen betydande effekt på beteendet hos de frilevande vithajarna. I de sammanfattande publikationerna finns det beskrivet försök där olika kontrasterande mönster har testats för att ”förvirra” hajar och på så sätt minska risken för attack mot människa (Hart och Collin 2015). Det finns dock ingen vetenskaplig forskning som visar att kontrasterande mönster har en effekt på broskfiskars beteende. LED-belysta flyktöppningar i trål har under ett försök visat sig minska bifångsten av småfläckig rödhaj (men inte pigghaj) i trålfisket efter hoppmussla (*Aequipecten opercularis*) utanför Isle of Man (Southworth 2015). När försöket upprepades på en annan plats hade LED-belysningen begränsad, eller ingen, effekt. I det chilenska garnfisket som är riktat mot broskfisk, med bland annat hammarhaj (*Sphyrna zygaena*), hundhajar (Mustelus spp.), blåhaj (*Prionace glauca*) och örnrockor (Myliobatis spp.) som målarter, har LED-lampor placerats i garnen i syfte att minska bifångst av fågel och sköldpadda (Bellini 2020). LED-belysning påverkade i denna studie inte fångsten av målarterna negativt. Slutsatsen från dessa studier är att visuella signaler snarare kan ses som attraherande än repellerande för broskfisk. Artificiellt ljus kan möjligen användas för att vägleda broskfisk ut från ett fiskeredskap, så som flyktöppningar i trål eller fällor, men sannolikt inte användas i avskräckande syfte.

<u>Fördelar med visuella signaler:</u>

- Potentiellt applicerbara i både aktiva (t.ex. trål) och passiva (t.ex. krok, garn och bur) redskap.
- Eventuellt låg tillverkningskostnad vilket gör metoden relativt billig att använda för fiskaren.

<u>Nackdelar med visuella signaler:</u>

- Begränsad effekt gällande reduktion av fångst i fiskeredskap (snarare indikationer på att ljussignaler attraherar broskfiskar).

3.4. Elektromagnetiska signaler

Forskning kring hur broskfiskars elektromagnetiska sinne kan utnyttjas för att påverka deras beteende har pågått sen 1970-talet. Syftet var från början att finna metoder för att skydda människor från hajangrepp, men sen 1990-talet har ökat fokus för denna forskning varit reduktion av oönskad fångst av broskfisk i fiskeredskap (Hart och Collins 2015). Grundprincipen i den tekniska lösningen bygger på att överstimulering av de lorenzinska ampullerna skapar en obehagskänsla för fisken vilket i sin tur medför en förändring i dess beteende. De elektromagnetiska lösningar som tagits fram för att skapa förutsättningar för att ge obehagskänslor hos broskfiskar kan delas i tre kategorier; aktiva elektriska lösningar, elektropositiva metaller, och permanentmagneter.

3.4.1. Aktiva elektriska lösningar

Aktiva elektriska lösningar innebär att ström tillförs till elektroder i vattnet från ett batteri eller ett elektriskt nätverk, för att skapa ett (svagt) elektriskt fält. Denna lösning har framförallt använts i produkter som avser att skydda människor från hajagrepp. Företaget Ocean Guardian (https://ocean-guardian.com/) säljer flera olika typer av aktiva elektriska produkter för både personskydd och för att avskräcka haj från stränder och akvakulturanläggningar. Några av dessa produkter har utvärderats vetenskapligt och har bevisad avskräckande effekt på haj (Kempster m. fl. 2016). Aktiva elektroniska lösningar har även utvädrats som metod för att undvika fångst av sågfisk (*Pristis pristis*) i det australiensiska räkfisket med trål (Abrantes m. fl. 2020; 2021), och för reduktion av fångst av broskfisk i det kustnära garnfisket i Indonesien (Fitri m. fl. 2018). Abrantes m. fl. (2020, 2021), som genomförde försök med fisk i fångenskap, kunde inte visa att aktiva elektroniska fält är en lämplig lösning för att undvika fångst av sågfisk i trål. Sågfisken reagerade visserligen på de elektriska fälten, men inte i den omfattningen att det bedömdes användbart för att hindra oönskade fångster. Författarna utesluter dock inte att metoden skulle kunna användas i trålfisket och föreslår fortsatt forskning där elektriska fält placeras framför trålen likt den metod som används vid elektrofiske i Nordsjön (Soetaert m fl. 2015). Fitri m. fl. (2018), beskriver i sin studie en teknisk lösning som de kallar ”Electro Shield System” (ESS). Denna produkt, som sannolikt även tillverkats av författarna, genererade elektromagnetiska vågor kring 55 Hz. När ESS användes reducerades fångsten av broskfisk i garn med 5,26 %. Studien av Fitri m. fl. (2018) är emellertid av så dålig kvalité att det inte går att utläsa vilken experimentuppställning man använt sig av eller hur den minskade fångsten av broskfisk kvantifierades. Utifrån de beteendestudier som genomförts på broskfisk i fångenskap (t.ex. Howard m .fl. 2018; Jordan m fl. 2011), så är det tydligt att beteendet hos bland annat pigghaj kan påverkas med svaga aktiva elektroniska fält. Dessvärre finns det än så länge få vetenskapliga belägg för att

aktiva elektroniska metoder är praktiskt användbara för att undvika fångst av broskfisk i fiskeredskap. Ett sätt att öka obehagskänslan hos broskfisk från en aktiv elektronisk lösning, och därmed öka eventuella avskräckande effekter kopplat till fiskeredskap, skulle kunna vara att tillföra mer ström och därmed skapa ett kraftigare elektriskt fält. För att skapa starka elektriska fält över större avstånd så krävs det dock mycket energi (vilket gör det opraktisk och dyrt), och det riskerar även skada eller döda organismer, inklusive människor, som kommer för nära elektroderna (Abrantes m. fl. 2021).

Fördelar aktiva elektriska lösningar:

- Potentiellt applicerbara i både aktiva (t.ex. trål) och passiva (t.ex. krok, garn och bur) redskap.
- Bevisad effekt på beteende hos flera arter, bland annat pigghaj i fångenskap.

Nackdelar aktiva elektriska lösningar:

- Saknar bevisad effekt gällande reduktion av oönskad fångst av broskfisk i fiskeredskap.

3.4.2. Elektropositiva metaller

Elektropositiva metaller är metalliska grundämnen eller legeringar som genererar elektrisk spänning då de sänks ner i en elektrolyt så som havsvatten. Den elektriska spänningen skapas under en kemisk process (hydrolys) som resulterar i att metallen sönderfaller. De elektropositiva metallerna som använts för att avskräcka broskfisk tillhör i huvudsak de så kallade lantanoiderna i det periodiska systemet (så som cerium, praseodym och neodym) och olika legeringar av dessa. Spänningen som produceras under hydrolysen av dessa metaller beräknas vara detekterbar för broskfisk på ett avstånd upp till 85 cm, och beroende på vilken legering som används varierar hastigheten för sönderfallet av metallen mellan 0,2 – 1,6 g per timme (McCutcheon & Kajiura 2013). Elektropositiva metaller har använts i flera olika tekniska lösningar för att minska oönskad fångst av haj i fisket med krok. Hutchinson m fl. (2012) visade att ett sänke av elektropositiv metall fäst nära kroken minskade oönskad fångst av juvenil flerhornig hammarhaj (*Sphyrna lewini*). Minskade fångster gick dock inte att påvisa för högfenad haj (*Carcharhinus plumbeus*), tigerhaj (*Galeocerdo cuvier*), makohaj (*Isurus oxyrinchus*) eller blåhaj (*Prionace glauca*) som även ingick i denna studie. På liknande sätt visade O`Connell m. fl. (2012) att en cirkelkrok med elektropositiv metall minskade oönskad fångst av pigghaj med 28.2 %, medan en minskad fångst av knaggrocka eller rockan *Dipturus laevis* inte gick att påvisa. Det finns även studier som genomgående visat negativa resultat gällande den här tekniska lösningens

effektivitet. Efter ett storskaligt experiment som genomfördes under kommersiellt fiske med krok i nordvästra Atlanten konstaterade till exempel Godin m. fl (2013) att det inte var någon skillnad i fångst mellan krokar med elektropositiv metall och krokar utan elektropositiv metall för samtliga arter av broskfisk som påträffades. Användandet av elektropositiv metall visade sig även vara både dyrt och tidskrävande, eftersom metallen förbrukas i vattnet så behövde den konstant ersättas. Slutsatsen från denna studie var att elektropositiva metaller inte är praktiskt användbart för att minska oönskade fångster av broskfisk i det kanadensiska krokfisket.

Fördelar med elektropositiva metaller:

- Bevisad effekt på oönskad fångst av vissa arter, bland annat pigghaj, i fiske med krok.

Nackdelar med elektropositiva metaller:

- Kort verkningsavstånd för den förväntade effekten.
- Metallen förbrukas konstant i kontakt med vatten, och måste därför kontinuerligt ersättas.
- Potentiellt dyrt och opraktiskt.
- Flera större studier har inte påvisat en effekt för flera arter.

3.4.3. Permanentmagneter

Permanentmagneter är magnetiska material som ger upphov till ett konstant magnetfält oberoende av yttre energikällor. När en broskfisk passerar genom ett magnetfält påverkas de lorenzinska ampullerna indirekt genom elektromagnetisk induktion (Hart och Collins 2015). Permanentmagneter, i form av ferritmagneter och så kallade sällsynta jordmagneter (neodymmagneter), har i huvudsak använts i syfte att reducera oönskad fångst av broskfisk i fisket med krok. Ferritmagneter är relativt billiga, sönderfaller inte i havsvatten och genererar magnetfält i storleksklassen 2000 – 5000 Gauss. Neodymmagneter innehåller komponenter av elektropositiva metaller (kapitel 2.4.2), vilket gör att de dels är betydligt dyrare än ferritmagneter, men även att de sönderfaller i havsvatten om de inte är inkapslade. Fördelen med neodymmagneter är att de genererar betydligt kraftigare magnetiska fält (8300 – 14100 Gauss) jämfört med ferritmagneter. Styrkan på det magnetiska fält som genereras runt en permanentmagnet är omvänt proportionell mot kvadraten på avståndet från källan, dvs. styrkan avtar med ökat avstånd (Hart och Collins 2015). Det är oklart vid vilken styrka ett magnetfält ger upphov till elektromagnetisk induktion som upplevs obehagligt för broskfiskar. Smith & O´Connell (2014) visade att småfläckig rödhaj uppvisade ett undvikande beteende

på ett avstånd av 2 – 20 cm från en neodymmagnet, vilket skulle motsvara 21 – 2152 Gauss. Både ferritmagneter och neodymmagneter har visat sig kunna reducera oönskad fångst av broskfisk i fisket med krok (t.ex. O'Connell m. fl. 2010; Robbins m. fl. 2011). Tyvärr visar dessa studier även att permanentmagneternas påverkan på beteendet hos broskfisk endast gäller vissa arter eller under vissa förutsättningar. Robbins m. fl. (2010) visade att enskilda individer av galapagoshaj (*Carcharhinus galapagensis*) undviker bete som presenterades i anslutning till permanentmagneter, men då det blev fler än en individ kring betet hade det magnetiska fältet inte längre någon repellerande effekt. Det finns även studier som visat att permanentmagneter till och med kan öka fångsterna av broskfisk. Fångsterna av blåhaj var högre på magnetiska krokar relativt kontrollkrokar då permanentmagneter testades i krokfisket utanför Azorerna (Porsmoguer m. fl. 2018). Permanentmagneter har även testats i fisket med bur. Richards m. fl. (2018) visade att fångsterna av hajarten *Brachaelurus waddi* minskade med upp till 30 % då ferritmagneter placerades runt ingången på de burar som används i fisket utanför New South Wales (Australien). En uppenbar nackdel med permanentmagneter, då det kommer till praktisk användande i fiske, är just deras magnetiska egenskaper. Magneter som kommer för nära varandra, eller för nära andra metallobjekt som t.ex. ett båtskrov, riskerar att gå ihop och fastna. Detta gör att magneter är svåra att hantera, skapar trassel i fiskeutrustningen och kan vara potentiellt farliga i form av klämrisk.

Fördelar med permanentmagneter:

- En enkel och relativt billig teknisk lösning som inte kräver yttre energitillförsel.
- Bevisad effekt för vissa arter och under vissa förutsättningar.

Nackdelar med permanentmagneter:

- Kort verkningsavstånd för teoretisk effekt.
- Potentiellt opraktiska och svårhanterliga
- Begränsad effekt gällande reduktion av fångst i fiskeredskap.

3.5. Övriga tekniska lösningar

Utöver tekniska lösningar som är baserade på broskfiskarnas specifika sinnesorgan och beteende, finns där även andra parametrar/egenskaper hos fiskeredskap som kan påverka fångstbarheten. Eftersom påverkan av dessa parametrar generellt gäller även för andra arter av marina organismer och inte är relaterat till egenskaper

specifika för broskfiskar, beskrivs de här endast översiktligt för de typer av fiskeredskap som är fokus i denna rapport.

I fisket med tråll så har maskstorleken i olika delar av trålen, farten med vilken trålen dras genom vattnet och trålöppningens utformning alla en viss betydelse för fångstbarheten av bland annat broskfisk. Det som dock hittills visat sig vara en av de effektivaste tekniska lösningarna för att minska oönskad fångst av broskfisk i fisket med tråll är användandet av en artsorterande rist (Sacchi 2021). Olika typer av rist har implementerats i flera olika typer av fisken med tråll på flera olika platser i välden. Syftet har oftast inte har varit att reducera oönskade fångster av broskfisk utan istället minskade bifångster av kommersiellt viktiga arter av fisk, marina däggdjur eller kräldjur (Turtle Excluder Devices ”TEDs” är numera ett eget begrepp inom rist-lösningar för tråll). Då flertalet av de arter av broskfisk som fångas i trålfisket är av större storlek än målarten, och därmed kan sorteras ut ur fångsten på ett likande sätt som t.ex. en stor torsk eller havssköldpadda, så har implementeringen av rist i trålfisket även medfört en signifikant minskning i fångsten av broskfiskar (Sacchi 2021). Det finns även exempel på när TEDs modifierats för att reducera specifikt fångsten av broskfisk. Garstin & Oxenford (2018) visade att en minskning av spaltbredden och addering av en extra tvärgående ribba i den TED som används i det Guyanska räkfisket minskade fångsterna av broskfisk med 40 %.

I fisket med garn påverkas fångstbarheten av bland annat garnets maskstorlek, upphängning, trådtjocklek och tillverkningsmaterial. Genom ändringar av dessa parametrar kan fångst av oönskade arter eller storlekar reduceras (Sacchi 2021). Ett exempel på där detta nyttjats för att specifikt reducera fångsten av broskfisk är garnfisket riktat mot fläckig kungsmakrill (*Scomberomorus maculatus*) utanför Australien. Thorpe & Frierson (2009) visade att oönskad fångst av vitprickig spetsnoshaj (*Rhizoprionodon terraenovae*) kan reduceras i detta fiske genom att öka den vertikala spänningen i garnet. Denna reduktion av oönskad fångst, som inte påverkade fångsten av målarten, kan förklaras av att fler individer av haj ”studsade” mot garnet när det sträckts i vertikalled med hjälp av mer flytkraft i ovankant och mer sänken i underkant (Thorpe & Frierson 2009).

I krokfisket påverkas fångstbarheten av olika arter och storlekar bland annat av typen av krok som används (cirkel eller J-krok), storleken på kroken, typ av bete med vilket kroken agnas, och hur lång tid kroken är i vattnet (Sacchi 2021). Utifrån tillgänglig litteratur har en ändring av dessa parametrar ingen generell påverkan på fångstbarheten av broskfisk. Förändringar enligt ovan kan dock ha betydelse för fångstbarheten av specifika arter eller storlekar av broskfisk (Patterson m. fl. 2014). I fisket med burar är fångstbarheten beroende av bland annat ingången beskaffenhet och vilken typ av bete som används för att locka fisk till buren. Ändrad storlek eller

utformning på burens ingång har visat sig påverka fångsten av säl i Svenskt fiske med torskburar (Königson m. fl. 2015), och potentiellt kan likande lösningar reducera även eventuella oönskade fångster av broskfisk i fisket med bur.

3.6. Faktorer som kan påverka effekten av tekniska lösningar

Det finns ett flertal abiotiska faktorer som kan påverka effekten och utfallet av de tekniska lösningar som presenteras i denna rapport. Spridning av kemiska substanser, akustiska signaler och elektromagnetiska fält är alla till viss del beroende av vattnets rörelse, kemiska sammansättning och temperatur (Shacci 2021). Visuella stimuli är beroende av siktdjup och ljusförhållanden. Det som dock har störst betydelse för effekten av dessa tekniska lösningar är sannolikt biologiska faktorer. Broskfiskar är en stor grupp med avsevärd skillnad och variation mellan olika arter i sinnenas känslighet, samt artens livsbetingelser och ekologi (Hart & Collin 2015). Utifrån de resultat som framkom under litteraturstudien som presenteras i den här rapporten så är det även uppenbart att individer av samma art kan uppvisa olika beteende beroende på bland annat nivå av hunger, förekomst av artfränder och graden av intraspecifik konkurrens.

4. Sammanfattning och rekommendation för svenskt yrkesfiske

Resultatet från denna litteraturstudie tyder på att det idag inte finns en uppenbar kandidat av teknisk lösning som utgår från broskfiskarnas specifika sinnesorgan och beteende, som skulle kunna användas för att minska den oönskade fångsten av broskfisk i det svenska yrkesfisket. Den repellerande effekten som skapas av de tekniska lösningar som är i fokus i denna rapport har i samtliga fall visat sig fungera bara för vissa arter eller under vissa förutsättningar. För att förstå varför det är skillnad i beteende mellan arter och mellan olika individer av samma art, och hur detta kan hanteras eller utnyttjas för att minska oönskade fångster av broskfiskar, krävs mer forskning om respektive arts ekologi och en bättre kunskap om de neurologiska processerna hos broskfiskar i relation till olika typer av stimuli.

Givet nuvarande läge med avseende på utbredning och abundans av broskfisk i svenska vatten och oönskade fångster av dessa (Börjesson m. fl 2022), samt redskapsanvändning i det svenska fisket (Bergenius m. fl. 2018), så är den åtgärd som sannolikt skulle ge störst positiv effekt för bestånden av broskfisk ett utökat användande av rist i fisken med trål. Relativt fisket med trål så är fisket med krok och garn mycket litet på den svenska västkusten där broskfiskarna förekommer. En av anledningarna till detta är enligt yrkesfiskarna (personlig kommentar, Christian Johannisson) att oönskade fångster av pigghaj har blivit ett allt större problem. Yrkesfiskarna menar att detta problem är så stort att det för närvarande inte går att bedriva ett ekonomiskt hållbart garnfiske på kustnära hårdbottnar längs den svenska västkusten, då pigghajarna förstör både fångsten och redskapen. För att minska oönskade fångster av pigghaj i fisket med garn har denna studie visat två tekniska lösningar som har större potential än övriga. Placering av mikrofoner av typen ”Sharkstopper®” (se kapitel 3.2) kan i teorin verka avskräckande över större avstånd och därmed minska närvaron av pigghaj i området där garnen placeras. Minskad närvaro av dessa toppredatorer skulle eventuellt även kunna bidra till ökad aktivitet av målarterna i fisket, som ofta är bytesdjur för pigghajarna, och därmed även ge ökade fångster. För att reducera fångsten av pigghaj i garnen kan även en lösning vara att öka spänningen i garnet genom ökad vertikal sträckning (se kapitel 3.5). Båda dessa lösningar är emellertid i dagsläget teoretiska. Det behövs mer forskning kring hur effektiva de är, hur de påverkar fångsten av målarten i fisket,

samt vilka eventuella ekosystemeffekter som kan uppstå vid användandet innan det går att göra en bedömning om de kan vara lösningar lämpliga för svenskt yrkesfiske.

Denna studie har varit begränsad till litteratur publicerad på engelska. Det är alltså möjligt att det finns publikationer för andra tekniska lösningar, eller andra resultat för ingående lösningar, än de som presenterats här publicerade på andra språk. Eftersom engelska är huvudspråket för vetenskapliga publikationer globalt, så är det emellertid osannolikt att det finns ytterligare vetenskapliga studier att tillgå och som även redovisar en teknisk lösning som är effektivare än de som presenterats i den här rapporten.

Referenser

Abrantes, K., Barnett, A., Kyne, P.M., Laird, A., Seymour, J., Squire, L., Huveneers, C. (2020). Can sawfish bycatch within the Northern Prawn Fishery be mitigated using an electric field? Carins, CC BY 3.0.

Abrantes, K., Barnett, A., Soetaert, M., Kyne, P.M., Laird, A., Squire, L., Seymour, J., Wueringer, B.E., Sleeman, J., Huveneers, C. (2021). Potential of electric fields to reduce bycatch of highly threatened sawfishes. Endangered Species Research 46, 121–135. https://doi.org/10.3354/esr01146

Bergenius, M., Ringdahl, K., Sundelöf, A., Carlshamre, S, Wennhage, H. Valentinsson, D. (2018). Atlas över svenskt kust- och havsfiske 2003-205. Aqua reports 2018:3. Sveriges lantbruksuniversitet, Institutionen för akvatiska resurser, Drottningholm Lysekil Öregrund. 245 s.

Braccini, M., Rijn, J.V., Frick, L., 2012. High Post-Capture Survival for Sharks, Rays and Chimaeras Discarded in the Main Shark Fishery of Australia? PLOS ONE 7, e32547. https://doi.org/10.1371/journal.pone.0032547

Börjesson, P., Norén, K., Valentinsson, D. (2022). Occurrence of sharks, rays and rabbit fish in the Greater North Sea, and catches in Swedish fisheries in the Skagerrak/Kattegat and the eastern North Sea. Opublicerat manuskript. Sveriges lantbruksuniversitet, Institutionen för akvatiska resurser, Drottningholm Lysekil Öregrund.

Clarivate. (2021). https://clarivate.com/webofsciencegroup/solutions/webofscience-platform/. Hämtad 2021-11-12.

Eide, W. m.fl. (red.). (2020). Tillstånd och trender för arter och deras livsmiljöer – rödlistade arter i Sverige 2020. SLU Artdatabanken rapporterar 24. SLU Artdatabanken, Uppsala.

Fiskeriverkets föreskrifter (FIFS 2004:36) om fiske i Skagerrak, Kattegatt och Östersjön.

Fitri Aristi, D., Boesono, H., Prihantoko, K.E., Gautama, D.Y. (2018). Electro shield system applications on set gill net as efforts to preserve shark resources. J. Phys.: Conf. Ser. 1025, 012022. https://doi.org/10.1088/1742-6596/1025/1/012022

FÖRORDNING (EU) nr 1380/2013 av den 11 december 2013 om den gemensamma fiskeripolitiken, om ändring av rådets förordningar (EG) nr 1954/2003 och (EG) nr 1224/2009 och om upphävande av rådets förordningar (EG) nr 2371/2002 och (EG) nr 639/2004 och rådets beslut 2004/585/EG. Europeiska unionens officiella tidning 20.12.2013.

FÖRORDNING (EU) 2021/92 av den 28 januari 2021 om fastställande för 2021 av fiskemöjligheterna avseende vissa fiskbestånd och grupper av fiskbestånd i unionens vatten och, för unionsfiskefartyg, i vissa andra vatten. Europeiska unionens officiella tidning 29.01.2021.

Godin, A.C., Wimmer, T., Wang, J.H., Worm, B. (2013). No effect from rare-earth metal deterrent on shark bycatch in a commercial pelagic longline trial. Fisheries Research 143, 131–135. https://doi.org/10.1016/j.fishres.2013.01.020

Howard, S., Brill, R., Hepburn, C., Rock, J. (2018). Microprocessor-based prototype bycatch reduction device reduces bait consumption by spiny dogfish and sandbar shark. ICES Journal of Marine Science 75, 2235–2244. https://doi.org/10.1093/icesjms/fsy098

Hutchinson, M., Wang, J.H., Swimmer, Y., Holland, K., Kohin, S., Dewar, H., Wraith, J., Vetter, R., Heberer, C., Martinez, J. (2012). The effects of a lanthanide metal alloy on shark catch rates. Fisheries Research 131–133, 45–51. https://doi.org/10.1016/j.fishres.2012.07.006

Jordan, L.K., Mandelman, J.W., Kajiura, S.M. (2011). Behavioral responses to weak electric fields and a lanthanide metal in two shark species. Journal of Experimental Marine Biology and Ecology 409, 345–350. https://doi.org/10.1016/j.jembe.2011.09.016

Kempster, R.M., Egeberg, C.A., Hart, N.S., Ryan, L., Chapuis, L., Kerr, C.C., Schmidt, C., Huveneers, C., Gennari, E., Yopak, K.E., Meeuwig, J.J., Collin, S.P. (2016). How Close is too Close? The Effect of a Non-Lethal Electric Shark Deterrent on White Shark Behaviour. PLOS ONE 11, e0157717. https://doi.org/10.1371/journal.pone.0157717

Kullander, O., Stach, T., Nyman, L., ... & Jilg, K. (2011). Nationalnyckeln till Sveriges Flora och Fauna. Ryggsträngsdjur: Lansettfiskar–broskfiskar, Chordata: Branchiostomatidae–Chondrichthyes. ArtDatabanken, SLU.

Königson, S., Lövgren, J., Hjelm, J., Ovegård, M., Ljunghager, F., Lunneryd, S.-G. (2015). Seal exclusion devices in cod pots prevent seal bycatch and affect their catchability of cod. Fisheries Research 167, 114–122. https://doi.org/10.1016/j.fishres.2015.01.013

McCutcheon, S.M., Kajiura, S.M. (2013). Electrochemical properties of lanthanide metals in relation to their application as shark repellents. Fisheries Research 147, 47–54. https://doi.org/10.1016/j.fishres.2013.04.014

Nelson, J.S., Grande, T.C. & Wilson, M.V.H. (2016). Fishes of the World, 5th edition. 5th uppl. Hoboken, NJ, USA: John Wiley & Sons, Inc.

O'Connell, C.P., Abel, D.C., Rice, P.H., Stroud, E.M., Simuro, N.C. (2010). Responses of the southern stingray (Dasyatis americana) and the nurse shark (Ginglymostoma cirratum) to permanent magnets. Marine and Freshwater Behaviour and Physiology 43, 63–73. https://doi.org/10.1080/10236241003672230

Oliver, S., Braccini, M., Newman, S.J., Harvey, E.S. (2015). Global patterns in the bycatch of sharks and rays. Marine Policy 54, 86–97. https://doi.org/10.1016/j.marpol.2014.12.017

Polpetta, M., Piva, F., Gridelli, S., Bargnesi, F. (2021). Behavioural responses in the sand tiger shark (Carcharias taurus) to permanent magnets and pulsed magnetic fields. Marine Biology Research 17, 41–56. https://doi.org/10.1080/17451000.2021.1887496

Porsmoguer, S.B., Bănaru, D., Boudouresque, C.F., Dekeyser, I., Almarcha, C. (2015). Hooks equipped with magnets can increase catches of blue shark (Prionace glauca) by longline fishery. Fisheries Research 172, 345–351. https://doi.org/10.1016/j.fishres.2015.07.016

Richards, R.J., Raoult, V., Powter, D.M., Gaston, T.F. (2018). Permanent magnets reduce bycatch of benthic sharks in an ocean trap fishery. Fisheries Research 208, 16–21. https://doi.org/10.1016/j.fishres.2018.07.006
Robbins, W.D., Peddemors, V.M., Kennelly, S.J. (2011). Assessment of permanent magnets and electropositive metals to reduce the line-based capture of Galapagos sharks, Carcharhinus galapagensis. Fisheries Research 109, 100–106. https://doi.org/10.1016/j.fishres.2011.01.023
Roskov, Y., Ower, G., Orrell, T., Nicolson, D., Bailly, N., Kirk, P.M., Bourgoin, T., DeWalt, R.E., Decock, W., Nieukerken, E., Zarucchi, J., Penev, L., eds. (2021). Species 2000 & ITIS Catalogue of Life, 25th March 2019. Digital resource at www.catalogueoflife.org/col. Species 2000: Naturalis, Leiden, the Netherlands. ISSN 2405-8858.
SLU Artdatabanken. (2021). https://www.artdatabanken.se/ Hämtad 2021-11-08.
Smith, L.E., O'Connell, C.P. (2014). The effects of neodymium-iron-boron permanent magnets on the behaviour of the small spotted catshark (Scyliorhinus canicula) and the thornback skate (Raja clavata). Ocean & Coastal Management, Shark Defense 97, 44–49. https://doi.org/10.1016/j.ocecoaman.2013.05.010
Stenberg, C., Nyman, L. & Svensson, M. (2015). Västerhavets hajar och rockor. ArtDatabanken SLU, Uppsala
Stevens, J. D., Bonfil, R., Dulvy, N. K., Walker, P. A. (2000). The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems, ICES Journal of Marine Science, Volume 57, Issue 3, Pages 476–494
Thorpe, T. & Frierson, D. (2009). Bycatch mitigation assessment for sharks caught in coastal anchored gillnets. Fisheries Research, 98(1–3): 102–112.
Webb, J.F., Montgomery, J.C., Mogdans, J. (2008). Bioacoustics and the Lateral Line System of Fishes. In: Webb, J.F., Fay, R.R., Popper, A.N. (eds) Fish Bioacoustics. Springer Handbook of Auditory Research, vol 32. Springer, New York, NY. https://doi.org/10.1007/978-0-387-73029-5_5.
WWF. (2015). https://www.worldwildlife.org/initiatives/international-smart-gear-competition. Hämtad 2021-11-12.

Appendix 1. Zotero rapport – sammanfattande publikationer

Detta appendix innehåller titel, författare, sammanfattning (abstract) och information kring publicering för samtliga sammanfattande publikationer (reviews) som ingick i litteraturstudien. Publikationerna är sorterade i bokstavsordning utifrån efternamn på första författare.

Elasmobranch Bycatch in the Canadian Northwest Atlantic and Arctic Adjacent Seas: Composition, Biogeography, and Mitigation

Typ Tidskriftsartikel

Författare Aurelie Cosandey-Godin

Sammanfattning: Industrial fishing has profoundly changed the biological state of oceans and seas. While the direct impacts of overfishing on target stocks are being increasingly addressed, unwanted bycatch and discarding of non-target species remains a key challenge of contemporary fisheries management. Excess bycatch mortality is particularly threatening for intrinsically vulnerable species, such as sharks, skates, and rays (Class Chondrichthyes). QUESTION: In order to address these pressing concerns we ought to know where bycatch occurs in time and space, and how it can be solved through spatial-temporal management and modification of fishing technique. METHOD: These questions were addressed by developing novel geostatistical methods to track and quantify bycatch "hotspots" in the Northwest Atlantic and adjacent Arctic seas. These tools were applied to analyse (i) bycatch patterns of Greenland shark (Somniosus microcephalus), an emerging species of concern in expanding Arctic fisheries; (ii) bycatch of large sharks in pelagic longline fisheries; and, (iii) to estimate total discards of all elasmobranch species in Eastern Canadian fisheries. Additional research also clarified the role of circle hooks in reducing post-release mortality for sharks and field-tested electropositive metals as bycatch deterrents in longline fisheries. RESULTS: Areas of high bycatch were concentrated in southern Canadian waters bordering the United States: upper Bay of Fundy, Georges Bank, Browns Bank, and Emerald Basin, however northern latitudes were associated with bycatch of deep-water species - which are in need of greater attention. These patterns were driven by both

species' abundance and fishing intensity. In 2012, total discard amounts were estimated at 3250 mt (2722-3849, 95% credible intervals) for sharks and 1772 mt (1642-1911) for skates and rays. Total bycatch of large sharks was higher than previously assumed in pelagic longline fisheries. For bycatch mitigation circle hooks reduced post-release mortality, but electropositive shark repellents were not effective in reducing bycatch in pelagic longline fisheries. CONCLUSION: This dissertation clearly demonstrates the high spatiotemporal variability and inherent complexity of bycatch and supports the use of geostatistical models and fine-scale spatial management for elasmobranch conservation.

Webbadress https://DalSpace.library.dal.ca//handle/10222/56282

Datum 2015-03-31

Språk en

Bibliotekskatalog dalspace.library.dal.ca

Do by-catch reduction devices in longline fisheries reduce capture of sharks and rays? A global meta-analysis

Typ Tidskriftsartikel

Författare Brett Favaro

Författare Isabelle M Côté

Sammanfattning: By-catch in marine fisheries, particularly those using pelagic and demersal longlines, is a major driver of declines in abundance of sharks and rays around the world. A wide variety of by-catch reduction devices (BRDs), that is, modified gears designed to reduce incidental captures of a variety of marine species while maintaining target catch rates, have been proposed, but the extent to which BRDs actually reduce the risk of catching sharks and rays remains unclear. We performed a meta-analysis of 27 publications that reported the capture of sharks and rays and, in some cases, of targeted teleosts in longline gear deployed with and without BRDs. The risk of shark and ray capture differed between types of BRDs, but only one BRD type, longlines raised off the bottom, reduced by-catch significantly. Circle hooks did not reduce the risk of capturing sharks and rays but might improve discard survival and are inexpensive, which might make them effective in reducing the detrimental effects of longlining on these species. In addition to being generally ineffective, some devices, such as electropositive and magnetic repellents, are expensive and have inherent construction drawbacks that are likely to make them unsuitable for commercial use. Overall, most BRDs did not

affect the likelihood of catching targeted teleosts, but a substantial number of studies did not adequately assess target catch. We identified two poorly studied classes of BRD gear (i.e. raised demersal longlines, and monofilament nylon leaders), which represent promising directions for future research.

Webbadress https://onlinelibrary.wiley.com/doi/abs/10.1111/faf.12055

Publikation Fish and Fisheries

Datum 2015

Språk en

Bibliotekskatalog Wiley Online Library

DOI 10.1111/faf.12055

Sharks senses and shark repellents

Typ Tidskriftsartikel

Författare Nathan S. Hart

Författare Shaun P. Collin

Sammanfattning: Despite over 70 years of research on shark repellents, few practical and reliable solutions to prevent shark attacks on humans or reduce shark bycatch and depredation in commercial fisheries have been developed. In large part, this deficiency stems from a lack of fundamental knowledge of the sensory cues that drive predatory behavior in sharks. However, the widespread use of shark repellents is also hampered by the physical constraints and technical or logistical difficulties of deploying substances or devices in an open-water marine environment to prevent an unpredictable interaction with a complex animal. Here, we summarize the key attributes of the various sensory systems of sharks and highlight residual knowledge gaps that are relevant to the development of effective shark repellents. We also review the most recent advances in shark repellent technology within the broader historical context of research on shark repellents and shark sensory systems. We conclude with suggestions for future research that may enhance the efficacy of shark repellent devices, in particular, the continued need for basic research on shark sensory biology and the use of a multi-sensory approach when developing or deploying shark repellent technology.

Webbadress https://onlinelibrary.wiley.com/doi/abs/10.1111/1749-4877.12095

Publikation Integrative Zoology

Datum 2015

Språk en

Bibliotekskatalog Wiley Online Library

DOI 10.1111/1749-4877.12095

Trends in shark bycatch research: current status and research needs

Typ Tidskriftsartikel

Författare Juan M. Molina

Författare Steven J. Cooke

Sammanfattning: Over the last few decades, much effort has been devoted towards quantifying and reducing bycatch in marine fisheries. Of late, there has been a particular focus on sharks given that bycatch is a frequently listed threat for sharks on the International Union for the Conservation of Nature Red List. However, currently there are no quantitative reviews or syntheses that explore the issue of shark bycatch globally which is problematic given that such a synthesis could inform conservation actions and identify pressing research gaps. We performed a qualitative and quantitative survey of the peer-reviewed literature to characterize trends in shark bycatch research with a particular goal of identifying research needs and opportunities. Using a structured literature review we identified 103 papers that met our search criteria, with the first one published in 1993. Early research efforts focused on documenting the scope of bycatch (i.e., determining that sharks were indeed captured as bycatch), but more recently there have been increased efforts devoted to developing and evaluating bycatch reduction strategies for sharks. Research activity was most common in the North Atlantic (~40 % of the total articles analysed) with comparatively less research in other areas such as the Indo-Pacific region where shark bycatch is regarded as particularly common and problematic. Most studies were observational with comparatively fewer experimental and modeling studies, and even fewer that combined research approaches. Gear modifications (e.g., hook size and type for long lines, net size and mesh design for nets) were the most commonly evaluated strategy for reducing shark bycatch; however, development and use of techniques like repellents, or

seasonal area closures, or a combination of strategies, offer interesting possibilities that require further study. In addition, although many sharks are discarded, little is known about post-release survival or sub-lethal consequences of fisheries interactions, or evaluations of different fish handling strategies, making it difficult to quantify the true cost of bycatch or to recommend handling strategies to fishers. Although there are some inherent challenges with developing and testing shark bycatch reduction strategies, there is an urgent need to do so and this would be best achieved through interdisciplinary research that spans field, laboratory, and modeling realms.

Webbadress https://link.springer.com/article/10.1007/s11160-012-9269-3

Publikation Reviews in Fish Biology and Fisheries

Datum 2012/09/01

Språk en

Bibliotekskatalog link.springer.com

DOI 10.1007/s11160-012-9269-3

The emerging field of electrosensory and semiochemical shark repellents: Mechanisms of detection, overview of past studies, and future directions

Typ Tidskriftsartikel

Författare Craig P. O'Connell

Författare Eric M. Stroud

Författare Pingguo He

Sammanfattning: Since the sinking of the USS Indianapolis (CA-35) and associated shark attacks in 1945, the quest to find an effective shark repellent has been endless. Early efforts were focused on finding a shark repellent which would minimize the probability of a shark attack. However, studies illustrate that shark populations are drastically declining which has led to calls for effective management policies and practices to reduce both directed catch and bycatch of various shark species. With increased need for shark conservation, the focus has shifted to protecting sharks from harmful anthropogenic pressures, such as fishing gear and beach nets. Current shark repellent technologies which aim to minimize elasmobranch mortality in

fishing gears include: permanent magnets, electropositive metal (EPM) alloys, and semiochemicals. This paper will review present electrosensory and semiochemical shark repellents, the mechanisms of elasmobranch (e.g. shark, skate and ray) detection and repellency, species-specificity in elasmobranch response to the stimuli, and environmental and biological conditions which may influence repellent success. Future research to enhance our knowledge on electrosensory repellents and to improve the success of repellent implementation and application will be discussed.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569112003183

Publikation Ocean & Coastal Management

Bokserie Shark Defense

Datum August 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2012.11.005

Integrating the findings from this special issue and suggestions for future conservation efforts – A brief synopsis

Typ Tidskriftsartikel

Författare Craig P. O'Connell

Författare Victor N. de Jonge

Sammanfattning: The populations of several elasmobranch species have experienced a marked decline over the past several decades. Such declines may be attributed to the unsustainable harvest of these animals in combination with their K-selected life-history characteristics. To help reduce this mortality typically associated with commercial fisheries and beach nets, scientists have employed the use of electrosensory and chemical stimuli as elasmobranch deterrents. This paper describes the findings from several studies that assess elasmobranch deterrent

efficacy, briefly integrates these findings, and provides useful insight for future conservation approaches.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569114001707

Publikation Ocean & Coastal Management

Bokserie Shark Defense

Datum August 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2014.05.022

A review of shark bycatch mitigation in tuna longline fisheries

Typ Bok

Författare Heather Patterson

Författare Scott Hansen

Författare James Larcombe

Sammanfattning: Sharks are a significant component of the catch species in pelagic longline fisheries that generally target tuna and tuna-like species. They may be a target species in some cases, but are more often a byproduct (incidentally caught but retained) or a bycatch (incidentally caught but unwanted and discarded) species. Incidental catch of sharks in pelagic longline fisheries has raised concerns about the status of shark populations and the need for mitigation measures to reduce mortality. Despite these concerns, progress in research and implementation of bycatch mitigation measures for sharks has lagged behind measures for other bycatch species such as seabirds. A review of the most studied mitigation methods (generally defined as measures that reduce the incidence of sharks being caught on the gear) is undertaken here and is extended to include measures that reduce mortality once the shark is captured and brought to the boat.

Datum August 6, 2014

Bibliotekskatalog ResearchGate

Technical mitigation measures for sharks and rays in fisheries for tuna and tuna-like species: turning possibility into reality

Typ Tidskriftsartikel

Författare François Poisson

Författare Francisco Abascal Crespo

Författare Jim R. Ellis

Författare Pierre Chavance

Författare Bach Pascal

Författare Miguel. N. Santos

Författare Bernard Séret

Författare Maria Korta

Författare Rui Coelho

Författare Javier Ariz

Författare Hilario Murua

Sammanfattning: Tuna fisheries have been identified as one of the major threats to populations of other marine vertebrates, including sea turtles, sharks, seabirds and marine mammals. The development of technical mitigation measures (MM) in fisheries is part of the code of conduct for responsible fisheries. An in-depth analysis of the available literature regarding bycatch mitigation in tuna fisheries with special reference to elasmobranchs was undertaken. Studies highlighting promising MMs were reviewed for four tuna fisheries (longline, purse seine, driftnets and gillnet, and rod and line-including recreational fisheries). The advantages and disadvantages of different MMs are discussed and assessed based on current scientific knowledge. Current management measures for sharks and rays in tuna Regional Fishery Management Organizations (t-RFMOs) are presented. A review of relevant studies examining at-vessel and postrelease mortality of elasmobranch bycatch is provided. This review aims to help fisheries managers identify pragmatic solutions to reduce mortality on pelagic elasmobranchs (and other higher vertebrates) whilst minimizing impacts on catches of target tuna species. Recent research efforts have identified several effective MMs that, if

endorsed by t-RFMOs, could reduce elas-mobranchs mortality rate in international tropical purse seine tuna fisheries. In the case of longline fisheries, the number of operational effective MMs is very limited. Fisheries deploying driftnets in pelagic ecosystems are suspected to have a high elasmobranchs bycatch and their discard survival is uncertain, but no effective MMs have been field validated for these fisheries. The precautionary bans of such gear by the EU and by some t-RFMOs seem therefore appropriate. Recreational tuna fisheries should be accompanied by science-based support to reduce potential negative impacts on shark populations. Priorities for research and management are identified and discussed.

Webbadress https://hal.archives-ouvertes.fr/hal-01927071

Publikation Aquatic Living Resources

Datum 2016-10

Bibliotekskatalog HAL Archives Ouvertes

DOI 10.1051/alr/2016030

Overview of mitigation measures to reduce the incidental catch of vulnerable species in fisheries

Typ Rapport

Författare Jacques Sacchi

Sammanfattning: Interactions between fisheries and marine vulnerable species, in particular marine mammals, seabirds, sharks and rays, and sea turtles, represent a global conservation issue, and mitigating the impacts of these interactions is an important step to ensure the sustainability of fisheries. This literature review presents information on mitigation measures and techniques that have been developed and tested worldwide in order to address both the incidental catch of highly mobile species (marine mammals, seabirds, sharks and rays, and sea turtles) and depredation caused by dolphins. It is based on more than 300 documents, including peer-reviewed publications, reports from international organizations and papers available on the Internet. Most of the mitigation techniques illustrated are still under development and very few have been adopted through legislation. Mitigation measures are presented according to the main groups of fishing gear – gillnets and trammel nets, longlines and lines, trawls, purse seines, traps and pots – and subdivided according to the four main groups of vulnerable species: marine mammals, seabirds, sharks and rays, and sea turtles. Preventive and curative

approaches covering both technical measures (gear modifications, strategies, as well as acoustic, visual, magnetic and chemosensory deterrents) and management measures are described.

Webbadress http://www.fao.org/documents/card/en/c/cb5049en

Datum 2021-6-23

Språk en

Bibliotekskatalog DOI.org (Crossref)

Appendix 2. Zotero rapport – originalpublikationer

Detta appendix innehåller titel, författare, sammanfattning (abstract) och information kring publicering för samtliga originalpublikationer (original research) som ingick i litteraturstudien. Publikationerna är sorterade i bokstavsordning utifrån efternamnet på första författare.

Potential of electric fields to reduce bycatch of highly threatened sawfishes

Typ Tidskriftsartikel

Författare Kátya Abrantes

Författare Adam Barnett

Författare Maarten Soetaert

Författare Peter M. Kyne

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Sammanfattning: Sawfishes are among the most threatened families of marine fishes and are susceptible to incidental capture in net fisheries. Since bycatch reduction devices currently used in trawl fisheries are not effective at reducing sawfish catches, new methods to minimise sawfish bycatch are needed. Ideally, these should affect sawfish behaviour and prevent contact with the fishing gear. We tested the effects of electric fields on sawfish behaviour to assess the potential of

electric pulses in mitigating sawfish bycatch. Experiments were conducted in a tank where 2 electrodes were suspended in the water column, connected to a pulse generator, and placed across the swimming path of sawfish. Two largetooth sawfish Pristis pristis were tested in control conditions, in the presence of a baseline pulse, and of 5 variations of that pulse where 1 parameter (polarity, voltage, frequency, pulse shape, pulse duration) was altered at a time. Conditional inference trees were used to identify the effects of various parameters (e.g. treatment, individual) on reaction type, reaction distance, twitching presence and duration, and inter-approach times. Sawfish reacted to electric fields, but reaction distances were small (typically <1.2 m), and no field tested consistently led to reactions conducive to escaping from moving nets. The following parameters induced the most response in both individuals: bipolar current, rectangular shaped, 5-10 Hz, ~1500 μs duration, and 100 V. We recommend further research focussing on moving nets, testing a V-shaped electric array preceding the net mouth by at least 5 m, and testing a setup similar to electrotrawling.

Webbadress https://www.int-res.com/abstracts/esr/v46/p121-135/

Publikation Endangered Species Research

Datum 2021-10-21

Språk en

Bibliotekskatalog www.int-res.com

DOI 10.3354/esr01146

Can sawfish bycatch within the Northern Prawn Fishery be mitigated using an electric field?

Typ Rapport

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Sammanfattning: This project aimed to test the effect of electric fields on sawfish behaviour and to assess the potential for electric pulses to mitigate sawfish bycatch in prawn fisheries. The project was developed in collaboration with the Northern Prawn Fishery Industry Projects Manager Adrianne Laird and Dr Peter Kyne, principal investigator of National Environmental Research Programme/National Environmental Science Program Marine Biodiversity Hubs projects specialised in Northern Australia threatened species, including sawfishes. Sawfishes are among the most threatened family of marine fishes and are particularly vulnerable to incidental capture in trawl and gillnet fisheries. In northern Australia, their distribution range overlaps with that of several commercial fisheries, including the Northern Prawn Fishery. Given the inefficiency of current bycatch reduction devices in reducing sawfish bycatch, there is a pressing need to develop new approaches to minimise sawfish interactions with fishing gear. Ideally, those would involve mechanisms that prevent contact with the fishing gear, i.e. that affect the behaviour of sawfish, preventing them from entering the nets, without affecting catches of target species. Elasmobranchs (sharks and rays) have the ability to detect minute electromagnetic fields using highly sensitive electroreceptors. This sensory capability has been used to develop repellent technologies and the use of electric fields has been proposed as the method with the highest potential to reduce sawfish bycatch. The present project was developed to test the effect of electric fields on sawfish behaviour, to determine if a strong electric field can overwhelm their electrosensory system and dissuade them from approaching its source and/or elicit a fleeing behaviour. If successful, this technology could be incorporated into a device and attached to commercial fishing nets to reduce sawfish bycatch. The project consisted of tank experiments conducted at the Biopixel/James Cook University Aquarium facilities in Cairns (Queensland). The experimental tank was 4.6 × 6.0 m and had a 1200 L capacity. The apparatus that produced the electric field consisted of two 40 cm long electrodes suspended in-line and 112 cm apart, halfway through the water column. This setup was placed perpendicular to and against one side of the tank, across the swimming path of sawfish, and was connected to a laboratorial pulse generator by power leads. The generator used produces electrical pulse stimuli and allows the user to independently adjust the different pulse parameters including voltage, frequency, pulse duration, and pulse shape. Sawfish were subjected to electric pulses with different waveform characteristics, and to a control treatment with no electric pulse produced. The initial selection of the waveform parameters was guided by the electric field characteristics of commercially available products, which are personal shark deterrents previously shown to affect shark behaviour. This resulted in the selection

of a ‘Baseline’ waveform that seemed to best deter sawfish based on preliminary observations. Sawfish behaviour was tested in presence of the ‘Baseline’ pulse stimulus and five variations of that pulse, where only one parameter (polarity, voltage, frequency, pulse shape, pulse duration) was changed at the time to identify which change in pulse characteristics is most likely to improve the deterrent effect. Two Largetooth Sawfish individuals were tested, a 1.02 m (sawfish 1) and a 1.65 m (sawfish 2) total length, both males. Experiments were recorded with a video camera placed above the tank, and sawfish behaviour was coded using an event-logging software coupled with direct observations. Recorded behaviours included activity (swimming/resting), direction of approach in relation to the electrodes, reaction distance, reaction type, and presence/duration of twitching. Data was analysed using conditional inference trees ix to identify the effects of individual, treatment, treatment day, session number, trial number, approach number, and time of the day on 1) reaction distance, 2) inter-approach times (i.e. time between two consecutive approaches), 3) reaction type, 4) twitching presence, and 5) duration. Sawfish clearly sensed and reacted to all electric fields tested, but only when they were very close (typically within 1.2 m) to the electrode setup. Reactions included ‘twitching’ and rapid changes in swimming direction and speed. Upon swimming towards the electrode setup, four different behaviours were observed. Two of these were considered as desirable for the development of a sawfish repelling device: when the sawfish turned back after sensing the electric pulses, and when the sawfish changed swimming direction and continued on a path parallel to the electrodes, not crossing the strongest part of the electric field. These behaviours confirm that the sawfish can sense the electric field and is repelled by it. Two undesirable behaviours were also observed, including when the sawfish continued its path, swimming between the two electrodes and when the sawfish entered the electric field but lost the ability to swim away (freezing). These behaviours would lead to the sawfish entering the nets. Sawfish reacted differently and from further away following the first experimental sessions, suggesting that the animals are capable of learning to avoid an unpleasant stimulus. The two sawfish showed somewhat different reactions to the different treatments, and the treatments that best worked for the smaller individual were not as favourable for the larger individual, and vice-versa. This could be related to animal size or to intraspecific behavioural differences. Although sawfish reacted and were repelled by electric fields, they did not display a fleeing behaviour from a distance far away enough to avoid entering trawl nets. None of the waveforms used could repel from distances likely to be sufficient to deter sawfish from entering trawl nets (3–4 m). Additionally, exposure to the electric fields tested did not consistently lead to reactions conducive to escaping. This suggests that the electric pulses tested are unlikely to be useful to reduce sawfish bycatch in prawn trawlers. Increasing pulse voltage, frequency or duration could potentially improve the usefulness of an electric field repelling sawfish, but

higher energy waveforms would (i) be more challenging to implement (as larger units would be necessary to produce the electric field, which would be more expensive and have higher power consumption), (ii) increase potential stress and harmful side-effects in sawfish and other non-target species, and (iii) be more dangerous to humans. We suggest that the use of electric fields as sawfish deterrents should be revisited if/when technological advances allow for electric field propagation to be increased to elicit fleeing behaviour from greater distances. Until then, other mitigation measures that can reduce sawfish interactions should be investigated alongside an assessment of post-release survival and means to increase post-release survival if capture cannot be avoided and post-release survival is low.

Datum 2020

Ort Carins

Språk en

Bibliotekskatalog Zotero

Selective characteristics of a shark-excluding grid device in a Mediterranean trawl

Typ Tidskriftsartikel

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Sammanfattning: Galeus melastomus (blackmouth catshark) is often caught as bycatch in demersal trawls in the Mediterranean. In order to reduce bycatches of shark we tested an excluder grid with 90mm bar spacing during experimental fishing in the Tyrrhenian Sea (Western Mediterranean). Data collected made it possible to simultaneously evaluate catch losses of two commercial species: Nephrops norvegicus (Norway lobster) and Phycis blennoides (greater forkbeard). The escape outlet ahead of the grid and the codend were both mounted with a cover in order to collect escaped fish ahead of the grid and through the codend meshes. We used a structural model to estimate the contribution of the individual selective processes consisting of the excluder grid and the size selective codend. The 90mm excluder grid did not prove to be efficient in excluding G. melastomus, while it excuded more of P. blennoides. Catches of N. norvegicus were also affected by the

presence of the grid, but not as much as the catches of other two species. The results obtained for the experimental grid+codend setup were then compared with the estimated selectivity for the “codend alone” setup. Furthermore, by way of explorative simulation with other grid bar spacing, we concluded that reducing the grid bar spacing to 70mm would provide better compromise between the reduction of G. melastomus as bycatch and the catch rate of P. blennoides and N. norvegicus.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783615300448

Publikation Fisheries Research

Datum December 1, 2015

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2015.07.035

Null effects of decomposing shark tissue on baited-hook catches of elasmobranchs

Typ Tidskriftsartikel

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Sammanfattning: The effects of decomposing shark tissue on catches of benthic longlines targeting various carcharhinids were assessed to inform possible use as a semiochemical shark deterrent. During 15 nights fishing, four benthic longlines (each comprising 18–30 hooks baited with mullet, Mugil cephalus) were deployed to 12–56 m overnight for 12–21 h off eastern Australia. Two of the longlines had 2.0–3.0 kg of decomposing shark tissue placed into porous cylindrical canisters (520 × 105 mm polyvinyl chloride) secured to the mainline mostly between every three hooks (15–20 m apart), while the other two longlines had empty canisters. In total, 150 fish were caught, comprising 14 species of elasmobranchs and especially tiger sharks, Galeocerdo cuvier (31% of total). The decomposing shark tissue in the canisters had no effects on catches of any species or groups, with variability among most attributed to fishing depth (positive relationship) and also soak time (negative)

for carcharhinids and G. cuvier. Irrespective of the contents of the canisters and the lack of any semiochemical effects, there was some evidence of fewer sharks caught on adjacent hooks as moonlight increased, and possibly because of a visual response. There was no depredation of any decomposing shark tissue in the canisters, but three juvenile hooked sharks were substantially depredated, and presumably by larger individuals. Most (~70%) of the remaining hooked sharks survived. While this study showed no repelling effects of decomposing shark tissue, the conclusions are restricted to the experimental conditions, including the source of tissue and the distance between hooks, which might be used as upper limit in any future work assessing for effects.

Webbadress https://www.sciencedirect.com/science/article/pii/S2352485521002905

Publikation Regional Studies in Marine Science

Datum July 1, 2021

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.rsma.2021.101898

Factors affecting elasmobranch escape from turtle excluder devices (TEDs) in a tropical penaeid-trawl fishery

Typ Tidskriftsartikel

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Sammanfattning: The use of turtle excluder devices (TEDs) has resulted in fewer elasmobranchs (i.e. sharks and rays) caught in tropical penaeid-trawl fisheries. However, very few studies in the primary literature have quantified the effects of various TED design aspects affecting the escape of elasmobranchs. Data collected by observers on board commercial trawlers operating in Australia's northern prawn fishery (NPF) during 2001 were re-examined to quantify the effect of TEDs on catches of various elasmobranchs. During this sampling, a total of 6204 elasmobranchs were caught from 1440 net trawls. The 34 species identified, from 15 families and four taxonomic orders, were dominated by small carcharhinids (n = 2160, median total length = 75 cm) and dasyatids (n = 2030, median disc width = 24 cm). The TEDs assessed significantly reduced the numbers of large elasmobranchs caught: increasing fish size was found to result in higher escape for all taxonomic orders. Further, top-shooter TEDs increased the escape of Carcharhiniformes, while bottom-shooter TEDs facilitated greater escape of Myliobatiformes. Grid orientation had no effect on the escape of Orectolobiformes or Rhinopristiformes. Decreasing bar space was found to increase the escape of only one species, the Australian blacktip shark (Carcharhinus tilstoni). The TEDs facilitated the escape of several species of conservation interest including the globally endangered scalloped hammerhead (Sphyrna lewini) and zebra shark (Stegostoma fasciatum). However, the rostrum of the narrow sawfish (Anoxypristis cuspidata) inhibited the escape of this globally important species. Fishery-specific research is required to determine the appropriate TED bar spaces that reduce catches of elasmobranchs while minimising the loss of commercially important species.

Webbadress https://www.sciencedirect.com/science/article/pii/S016578361930311X

Publikation Fisheries Research

Datum April 1, 2020

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2019.105456

The effect of underwater sounds on shark behaviour

Typ Tidskriftsartikel

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Sammanfattning: The effect of sound on the behaviour of sharks has not been investigated since the 1970s. Sound is, however, an important sensory stimulus underwater, as it can spread in all directions quickly and propagate further than any other sensory cue. We used a baited underwater camera rig to record the behavioural responses of eight species of sharks (seven reef and coastal shark species and the white shark, Carcharodon carcharias) to the playback of two distinct sound stimuli in the wild: an orca call sequence and an artificially generated sound. When sounds were playing, reef and coastal sharks were less numerous in the area, were responsible for fewer interactions with the baited test rigs, and displayed less ‘inquisitive’ behaviour, compared to during silent control trials. White sharks spent less time around the baited camera rig when the artificial sound was presented, but showed no significant difference in behaviour in response to orca calls. The use of the presented acoustic stimuli alone is not an effective deterrent for C. carcharias. The behavioural response of reef sharks to sound raises concern about the effects of anthropogenic noise on these taxa.

Webbadress https://www.nature.com/articles/s41598-019-43078-w

Publikation Scientific Reports

Datum 2019-05-06

Språk en

Bibliotekskatalog www.nature.com

DOI 10.1038/s41598-019-43078-w

Not all electric shark deterrents are made equal: Effects of a commercial electric anklet deterrent on white shark behaviour

Typ Tidskriftsartikel

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Sammanfattning: Personal shark deterrents offer the potential of a non-lethal solution to protect individuals from negative interactions with sharks, but the claims of effectiveness of most deterrents are based on theory rather than robust testing of the devices themselves. Therefore, there is a clear need for thorough testing of commercially available shark deterrents to provide the public with information on their effectiveness. Using a modified stereo-camera system, we quantified behavioural interactions between Carcharodon carcharias (white sharks) and a baited target in the presence of a commercially available electric anklet shark deterrent, the Electronic Shark Defense System (ESDS). The stereo-camera system enabled accurate assessment of the behavioural responses of C. carcharias when

approaching an ESDS. We found that the ESDS had limited meaningful effect on the behaviour of C. carcharias, with no significant reduction in the proportion of sharks interacting with the bait in the presence of the active device. At close proximity (< 15.5 cm), the active ESDS did show a significant reduction in the number of sharks biting the bait, but this was countered by an increase in other, less aggressive, interactions. The ESDS discharged at a frequency of 7.8 Hz every 5.1 s for 2.5 s, followed by an inactive interval of 2.6 s. As a result, many sharks may have encountered the device in its inactive state, resulting in a reduced behavioural response. Consequently, decreasing the inactive interval between pulses may improve the overall effectiveness of the device, but this would not improve the effective deterrent range of the device, which is primarily a factor of the voltage gradient rather than the stimulus frequency. In conclusion, given the very short effective range of the ESDS and its unreliable deterrent effect, combined with the fact that shark-bite incidents are very rare, it is unlikely that the current device would significantly reduce the risk of a negative interaction with C. carcharias.

Webbadress https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0212851

Publikation PLOS ONE

Datum 11 mars 2019

Språk en

Bibliotekskatalog PLoS Journals

DOI 10.1371/journal.pone.0212851

Electro shield system applications on set gill net as efforts to preserve shark resources

Typ Tidskriftsartikel

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Sammanfattning: Sharks are kind of ETP biota (Endangered, Threatened, and Protected), and are generally caught as by catch during fishing operations. In addition, sharks are one of the biota that plays a role in the life cycle in coastal waters. The Electro Shield System (ESS) was a device with an electromagnetic wave source that the shark can detect and make it afraid. ESS can be applied to set gill net operation to prevent the shark from getting caught. The objective of the study was to analyze the ESS on shark catches during set gill net operations. The research method was experimental fishing, conducted in March-May 2017 in Bangka Belitung Islands, Indonesia. Design the study by comparing shark catches during set gill net operation between those without using ESS (control) and using ESS with frequency 55 Hz. The shark catch by using Electro Shield System was 5.26% lower than control (7.80%). T-student analysis (sign 0.05) indicates that there was a significant difference between the set gill net without ESS and using the ESS against shark biota as bycatch. This indicates that the application of ESS in set gill net can reduce the capture of shark as by catch.

Webbadress https://iopscience.iop.org/article/10.1088/1742-6596/1025/1/012022

Publikation Journal of Physics: Conference Series

Datum 05/2018

Språk en

Bibliotekskatalog DOI.org (Crossref)

DOI 10.1088/1742-6596/1025/1/012022

Reducing Elasmobranch Bycatch in the Atlantic Seabob (*Xiphopenaeus kroyeri*) Trawl Fishery of Guyana

Typ Tidskriftsartikel

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Sammanfattning: The Atlantic seabob (Xiphopenaeus kroyeri) trawl fishery is very important to Guyana, with 88 licensed industrial vessels harvesting about 15,000 mt annually, representing Guyana’s most valuable seafood export. All vessels are already using both teleost by—catch reduction devices (BRDs) and turtle excluder devices (TEDs) to satisfy international market standards. However, the key

stakeholder, the Guyana Association of Private Trawler Owners and Seafood Processors, is now seeking to access sustainable seafood markets through pursuing Marine Stewardship Council (MSC) certification. To this end, this study documents elasmobranch by—catch in the current fishery and examines the effectiveness of a modified TED (with a reduced bar spacing and the addition of a brace bar) in reducing elasmobranch by—catch. From July—August 2014, 131 tows were made, 80 of which represented simultaneous hauls with control and modified TEDs. One shark and 8 ray species were recorded. A statistically significant 40% decline in the elasmobranch catch rate was observed when using modified TEDs compared with control TEDs (mean by—catch rate dropped from 2.3 to 1.4 individuals per twin—trawl/h). Furthermore, modified TEDs significantly reduced the mean size of rays caught by 6.3%. This also resulted in a virtual elimination of 3 IUCN—designated 'Near Threatened' ray species in the by—catch, although having little effect on the capture of small—sized elasmobranch species, including the 'Critically Endangered' Caribbean Electric Ray (Narcine bancroftii). We conclude that the modified TED was successful in reducing the by—catch of vulnerable elasmobranch species and should advance progress towards attaining by—catch standards required for MSC certification.

Webbadress https://aquila.usm.edu/gcr/vol29/iss1/4

Publikation Gulf and Caribbean Research

Datum 2018-01-01

DOI 10.18785/gcr.2901.04

Variable response to electric shark deterrents in bull sharks, *Carcharhinus leucas*

Typ Tidskriftsartikel

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Sammanfattning: Although relatively rare, human-shark interactions and sharks bites are increasing globally, which has led to the development of various mitigation measures. Electric shark deterrents (ESDs) have, so far, been the most effective personal deterrents, but have only been scientifically tested on one of the species most frequently responsible for shark bites, i.e. white shark (Carcharodon carcharias). We tested the effectiveness of five ESDs (E-Shark Force, NoShark, Rpela v2, Freedom + Surf, Freedom + Surf—Shortboard) on bull sharks, Carcharhinus leucas, over a period of 21 days in September 2019, in New Caledonia. Standardised bait was attached 30 cm below an experimental board that had an active ESD for up to 15 min, or until a bull shark touched the bait or the board. We compared the numbers of baits taken, numbers of passes and reactions around the board, as well as the distance between the sharks and the board among ESDs and against a control board with bait and no active ESD. The Freedom + Surf was the most effective ESD, reducing the amounts of baits taken by 42.3%, while the Rpela v2 and Freedom + Surf—Shortboard also significantly reduced the number of baits taken by 16.5% and 16.2% respectively. Mean distance between sharks and the bait was not affected by the ESDs, but the number of approaches and the proportion of reactions were both significantly higher when the Freedom + Surf was active compared to other ESDs. The effectiveness of all ESDs decreased over time, with the likelihood of the bait being taken increasing and the number of approaches and distance between sharks and the bait decreasing. Our findings show that the ability of ESDs to deter bull shark varies between products, with the Freedom + Surf resulting in the most behavioural changes, followed by the Rpela v2 and Freedom + Surf—Shortboard. However, none of the products tested completely stopped sharks from taking the bait.

Webbadress https://www.nature.com/articles/s41598-020-74799-y

Publikation Scientific Reports

Datum 2020-10-21

Språk en

Bibliotekskatalog www.nature.com

DOI 10.1038/s41598-020-74799-y

No effect from rare-earth metal deterrent on shark bycatch in a commercial pelagic longline trial

Typ Tidskriftsartikel

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Sammanfattning: The indiscriminate capture of non-target organisms (bycatch) in commercial fisheries undermines the sustainable development of marine resources. In the Northwest Atlantic, blue sharks (Prionace glauca) account for most of the bycatch in the Canadian pelagic longline swordfish fishery. Minimizing the capture of this species is of interest to conservationists as well as the fishing industry because the high incidence of shark bycatch negatively affects fishing operations through bait loss and increased handling time. Electropositive metals (e.g., lanthanide) oxidize in seawater and create electric fields, which can alter the swimming and feeding behaviors of several species of sharks. Although electropositive metals appear to have the potential to reduce shark bycatch in pelagic longline fisheries, there have not been any controlled trials reported from a commercial fishery. A total of 7 sets (6300 hooks) with 3 hook treatments (standard hooks, hooks with electropositive metals (neodymium/praseodymium), and hooks with lead weights) were deployed in 2011 on the Scotian Shelf in the Northwest Atlantic. The results of this study show that electropositive metals did not reduce the catch of blue sharks or other common shark bycatch species, and hence do not present a practical bycatch mitigation measure for the Canadian longline fishery.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783613000246

Publikation Fisheries Research

Datum June 1, 2013

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2013.01.020

Greenland shark (Somniosus microcephalus) feeding behavior on static fishing gear, effect of SMART (Selective Magnetic and Repellent-Treated) hook deterrent technology, and factors influencing entanglement in bottom longlines

Typ Tidskriftsartikel

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Sammanfattning: The Greenland Shark (Somniosus microcephalus) is the most common bycatch in the Greenland halibut (Reinhardtius hippoglossoides) bottom longline fishery in Cumberland Sound, Canada. Historically, this inshore fishery has been prosecuted through the ice during winter but winter storms and unpredictable landfast ice conditions since the mid-1990s have led to interest in developing a summer fishery during the ice-free season. However, bycatch of Greenland shark was found to increase substantially with 570 sharks captured during an experimental Greenland halibut summer fishery (i.e., mean of 6.3 sharks per 1,000 hooks set) and mortality was reported to be about 50% due in part to fishers killing sharks that were severely entangled in longline gear. This study investigated whether the SMART (Selective Magnetic and Repellent-Treated) hook technology is a practical deterrent to Greenland shark predation and subsequent bycatch on bottom longlines. Greenland shark feeding behavior, feeding kinematics, and variables affecting entanglement/ disentanglement and release are also described. The SMART hook failed to deter Greenland shark predation, i.e., all sharks were captured on SMART hooks, some with more than one SMART hook in their jaw. Moreover, recently captured Greenland sharks did not exhibit a behavioral response to SMART hooks. In situ observations of Greenland shark feeding show that this species uses a powerful inertial suction mode of feeding and was able to draw bait into the mouth from a distance of 25-35 cm. This method of feeding is suggested to negate the potential deterrent effects of electropositive metal and magnetic alloy substitutions to the SMART hook technology. The number of hooks entangled by a Greenland shark and time to disentangle and live-release a shark was found to increase with body length.

Webbadress https://gateway.webofknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=DynamicDOIArticle&SrcApp=WOS&KeyAID=10.7717%2Fpeerj.4751&DestApp=DOI&SrcAppSID=C3pQ2bjQ3cZkBEFaTUi&SrcJTitle=PEERJ&DestDOIRegistrantName=PeerJ

Publikation Peerj

Datum MAY 17 2018

Språk English

Bibliotekskatalog Web of Science Nextgen

DOI 10.7717/peerj.4751

Applying a multidisciplinary framework for developing a shark bycatch reduction device

Typ Uppsats

Författare Sunkita Psyche Howard

Sammanfattning: The overarching aim of this multidisciplinary thesis was to contribute to the development of a novel shark bycatch reduction device (BRD) that both meets fishing operators' needs and is economically feasible. Following the multidisciplinary approach evident in existing frameworks developed for addressing bycatch problems, each chapter employed a different methodology drawn from a research discipline that provided a suitable set of tools for investigating a specific problem related to the overall goal. First, a literature review identified and evaluated global options available for mitigating elasmobranch bycatch on longline fishing gear. The aim of this review was to determine whether a shark bycatch reduction method currently exists that New Zealand longline fisheries could use to reduce their shark bycatch rates, and if not, identify promising emergent bycatch reduction methods as candidates for further development. The review found that no effective shark bycatch reduction methods or devices were commercially available to longline fishing operators, and identified electrosensory shark deterrents as an approach that showed potential for further development. Qualitative social research methods were then used to explore New Zealand longline fishing operators' perspectives on shark bycatch. Most interviews occurred in 2014 during a national campaign to legislate against shark finning in New Zealand waters. At this time, widespread popular opinion held that finning made

sharks an economically valuable bycatch or even target species in many longline fisheries. If sharks were valued by fishermen for their fins or otherwise targeted then it was unlikely that they would consider a shark BRD useful. Interviews with ling (Genypterus blacodes) and tuna (Thunnus spp.) longline fishermen showed that they viewed spiny dogfish (Squalus acanthias) and blue shark (Prionace glauca) bycatch in their respective fisheries as a significant operational and economic challenge that they were motivated to mitigate but lacked effective tools to do so. Interviews also revealed that fishermen viewed the issue of shark bycatch in the context of maximising target species catch rates rather than minimising shark bycatch rates. Following interviews with skippers, laboratory animal behaviour experiments tested the hypothesis that weak electric stimulus generated by a prototype BRD would deter spiny dogfish or sandbar sharks (Carcharhinus plumbeus) from eating bait. Sandbar sharks were used as a carcharhinid model for an important longline bycatch species, blue sharks. The primary function of the elasmobranch electric sense is to guide predatory strikes during the final stage of prey capture, so electrosensory stimulus could disrupt their close range feeding responses. Weak electric stimulus produced by a microcontroller attached to an array of carbon electrodes and powered by a 9 V battery was used to deter groups of sharks from eating bait. Electric stimulus significantly reduced bait consumption by each species in a laboratory setting. Bait consumption by groups of juvenile sandbar shark median declined by 85 % when bait was located 10 cm from active electrodes compared to when it was 2 m away. Bait consumption by groups of adult spiny dogfish declined by 50 % when bait was located 10 cm from active electrodes compared to when it was located 10 cm from inactive electrodes. Results from laboratory studies of electrosensory shark deterrents tend to produce larger effect sizes than similar stimuli applied in field studies. If these results translated to the field the effect size produced in the sandbar shark experiment could be adequate to meet fishermen's expectations of a successful BRD. Conversely, the smaller effect size and wide interquartile range in spiny dogfish bait consumption means that for this species, improvements in both effectiveness and consistency would be required for the prototype electrosensory BRD to meet fishing industry needs. Following the bait choice experiments, a spatial utilisation experiment tested the hypothesis that individual sandbar sharks avoided the location of carbon electrodes emitting weak electric stimulus. Sharks were not deterred from the location of either 4 Hz, 33 mA direct current or alternating current stimuli nor did their swimming speed change relative to a non-electric control. The absence of an avoidance response suggests that an electrosensory shark BRD based on this concept may not be applicable to non-baited fishing gears such as purse seine and trawl nets. The finding electrosensory stimuli that reduced bait consumption in the previous experiments did not also elicit spatial avoidance supports the premise that electrosensory deterrents interrupt shark feeding behaviours rather than eliciting an aversive

response. Finally, the economic impact of spiny dogfish in the inshore ling longline fishery was analysed quantitatively. Spiny dogfish and ling catch rates and export markets were assessed, then New Zealand government fisheries observer data were used to investigate a hypothesis that arose during skipper interviews, that spiny dogfish incur costs to inshore ling longline vessels by reducing ling catch rates. Overall, there was a significant weak positive relationship between spiny dogfish catch per unit effort (CPUE) and ling CPUE, which probably reflects these two species' spatial and temporal co-occurrence. On fishing lines in the upper quartile of spiny dogfish CPUE, there was a significant moderate negative relationship between spiny dogfish and ling CPUE. Median total hook occupancy in this fishery was 21 % but spiny dogfish alone could occasionally take up to 90 % of hooks. When spiny dogfish catch rates were high, the negative impact of spiny dogfish on ling CPUE could have been the result of hook occupation by spiny dogfish reducing the number of hooks available to ling. To reduce the highest spiny dogfish catches to a level below that likely to incur an opportunity cost in this fishery, the BRD would need to have an approximately 80 % effect size in the field. Based on the ratio of spiny dogfish to ling, an opportunity cost of high spiny dogfish catches in terms of 'lost' ling was estimated and valued at 34 cents per hook. The novel BRD under development produced weak electrosensory stimulus which was only perceptible to sharks at close range, which meant that every hook would require an individual BRD. Therefore, our estimates suggest a price ceiling of 34 cents per unit, above which the cost of a BRD outweighs its benefit in terms of increased ling catch. Increased durability could allow for the use of a more expensive device. However, based on the views of the three interviewed skippers, willingness to pay for a BRD is very low. Skipper access to better information, including our estimates of spiny dogfish bycatch-associated costs of ling catch, may provide increased incentives for BRD adoption. This thesis shows that an electronic BRD that produces electrosensory stimulus is a promising approach for mitigating carcharhinid shark bycatch, although it would require further development to become effective and reliable enough to be cost effective as a method of mitigating spiny dogfish bycatch in the ling longline fishery. This thesis also provides insight into an improved framework for developing bycatch reduction methods aimed at meeting fishing industry needs. Such a framework should involve initiating bycatch reduction research by conducting social research aimed at understanding fishing industry needs and perspectives on the bycatch problem. This can highlight the potential economic impacts, species of concern and key outcomes that industry would require for BRD uptake to occur. Proceeding to conduct an economic assessment of a bycatch problem's cost in a specific fishery can contribute to BRD cost-per-unit and minimum acceptable effect size estimates, which can then guide subsequent device development.

Webbadress https://ourarchive.otago.ac.nz/handle/10523/7824

Datum 2018

Språk en

Bibliotekskatalog ourarchive.otago.ac.nz

Microprocessor-based prototype bycatch reduction device reduces bait consumption by spiny dogfish and sandbar shark

Typ Tidskriftsartikel

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Författare Richard Brill

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Sammanfattning: Elasmobranchs contribute heavily to bycatch in longline fisheries globally, and an effective method of deterring them from baited fishing gear is needed. Electrosensory stimulus holds promise as a method of disrupting elasmobranch close-range feeding responses as their electric sense guides their final strike during prey capture. We used laboratory experiments to test the hypothesis that weak electric stimuli generated by a prototype electronic bycatch reduction device (BRD) could deter sandbar shark (Carcharhinus plumbeus) and spiny dogfish (Squalus acanthias) from eating bait. Voltage gradients <1 mV cm−1 at the location of bait were produced by an Arduino microcontroller powered by a 9 V battery and attached to carbon electrodes. Median bait consumption by groups of juvenile sandbar shark declined by 74% when bait was located 10 cm vs. 2 m from active electrodes. Spiny dogfish median bait consumption halved when bait was located 10 cm from active vs. inactive electrodes. Although laboratory studies often produce a larger effect for electrosensory shark deterrents than can be demonstrated during field trials, if the effects seen in our laboratory studies produced similar effects in the field, it could meet fishermen’s requirements for a BRD.

Webbadress https://doi.org/10.1093/icesjms/fsy098

Publikation ICES Journal of Marine Science

Datum December 1, 2018

Bibliotekskatalog Silverchair

DOI 10.1093/icesjms/fsy098

The effects of a lanthanide metal alloy on shark catch rates

Typ Tidskriftsartikel

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Författare Heidi Dewar

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Sammanfattning: Bycatch of sharks in longline fisheries has contributed to declines in shark populations and prompted the need for exploring novel technologies to reduce the incidental capture of sharks. One potential strategy is to exploit the unique electrosensory system of sharks, used to detect weak electric fields. Metals from the lanthanide series, made up of neodymium (Nd) and praseodymium (Pr), produce strong electric fields in water. In this study, we tested the effects of an Nd/Pr alloy on shark catch rates. Using longline fishing gear, we compared the catch rates of baited hooks affixed with either a block of the metal alloy (experimental) or a lead weight (control). Four experiments were conducted in different regions of the Pacific Ocean. Two bottom longline experiments were conducted inside and offshore of Kaneohe Bay, Hawaii. One of these experiments targeted young of the year scalloped hammerhead sharks (Sphyrna lewini), while the other targeted sandbar (Carcharhinus plumbeus) and tiger sharks (Galeocerdo cuvier). In the Southern California Bight (SCB), pelagic longlines were deployed to target mako (Isurus oxyrinchus) and blue sharks (Prionace glauca) and longlines targeting pelagic sharks were set in the Eastern Tropical Pacific (ETP) off Ecuador.

There was a significant reduction in juvenile hammerhead sharks caught on hooks with the lanthanide metal compared to the controls. In contrast, there was no difference in the catch rates for experiments targeting sandbar sharks in Hawaii or those conducted in the SCB and Ecuador. These results suggest that there are inter-specific differences regarding the effects of lanthanide metals on catch rates. This may reflect the diverse feeding strategies and sensory modalities used by shark species for detecting and attacking prey.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783612002123

Publikation Fisheries Research

Datum November 1, 2012

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2012.07.006

Effects of an Electric Field on White Sharks: In Situ Testing of an Electric Deterrent

Typ Tidskriftsartikel

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Sammanfattning: Elasmobranchs can detect minute electromagnetic fields, <1 nVcm–1, using their ampullae of Lorenzini. Behavioural responses to electric fields

have been investigated in various species, sometimes with the aim to develop shark deterrents to improve human safety. The present study tested the effects of the Shark Shield Freedom7™ electric deterrent on (1) the behaviour of 18 white sharks (Carcharodon carcharias) near a static bait, and (2) the rates of attacks on a towed seal decoy. In the first experiment, 116 trials using a static bait were performed at the Neptune Islands, South Australia. The proportion of baits taken during static bait trials was not affected by the electric field. The electric field, however, increased the time it took them to consume the bait, the number of interactions per approach, and decreased the proportion of interactions within two metres of the field source. The effect of the electric field was not uniform across all sharks. In the second experiment, 189 tows using a seal decoy were conducted near Seal Island, South Africa. No breaches and only two surface interactions were observed during the tows when the electric field was activated, compared with 16 breaches and 27 surface interactions without the electric field. The present study suggests that the behavioural response of white sharks and the level of risk reduction resulting from the electric field is contextually specific, and depends on the motivational state of sharks.

Webbadress https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0062730

Publikation PLOS ONE

Datum 2 maj 2013

Språk en

Bibliotekskatalog PLoS Journals

DOI 10.1371/journal.pone.0062730

Effects of the Shark Shield™ electric deterrent on the behaviour of white sharks (*Carcharodon carcharias*)

Typ Bok

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Sammanfattning: Although shark attacks are rare, their impacts on humans can have serious consequences. Attacks have increased in Australia from 6.5 to 15 incidents per year in the last decade. • One of the most popular personal protective devices used to reduce the risk of shark attack is the Shark ShieldTM electric deterrent, although its effectiveness has never been subject to independent scientific testing. • The present study tested the effects of the Shark Shield Freedom7TM electric deterrent on (1) the behaviour of white sharks (Carcharodon carcharias) around a static bait, and (2) the rates of attacks on a towed seal decoy. • A total of 116 trials using a static bait were undertaken at the Neptune Islands, South Australia and 189 tows were conducted using a seal decoy near Seal Island, South Africa. • The proportion of baits taken during static bait trials was not affected by the deterrent. The deterrent increased the time it took to take a static bait, and the number of interactions per approach. The effect of the Shark ShieldTM was not uniform across all sharks. • The number of interactions within two metres of the deterrent decreased when it was activated. • No breaches and only two surface interactions were observed during the dynamic seal decoy tows when the deterrent was activated, compared to 16 breaches and 27 surface interactions when the deterrent was not activated. • Although the fine-scale positioning and presence/absence data collected to assess the potential of the device to attract white sharks was limited to one trip, our results did not suggest that sharks were attracted to the deterrent. • The results showed that the deterrent had an effect on the behaviour of white sharks, but did not deter or repel them in all situations. • Future studies should focus on testing the effect of deterrents less than two metres from the bait, in locations not frequented by cage-diving operators, and on other potentially dangerous sharks, such as tiger sharks (Galeocerdo cuvier) and bull sharks (Carcharhinus leucas).

Datum June 1, 2012

Bibliotekskatalog ResearchGate

Behavioral responses to weak electric fields and a lanthanide metal in two shark species

Typ Tidskriftsartikel

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Sammanfattning: The unintentional catch of sharks on hooks intended for other fishes is an economic, environmental and safety concern. Recent research has sought to repel sharks from baited hooks by applying various lanthanide metals and alloys to stimulate the elasmobranch electrosensory system. We present a simplified experimental methodology to test responses of two shark species to a single lanthanide metal. Behavioral responses to prey-simulating, weak electric fields were quantified to establish the sensitivity of the electrosensory system in Squalus acanthias (Linnaeus, 1758) and Mustelus canis (Mitchill, 1815). Both species detected electric fields <1nVcm, and responded similarly to other elasmobranchs previously studied. Sharks were then presented with food affixed to treatments of acrylic, stainless steel or neodymium (Nd) metal. S. acanthias only fed in groups and fed from Nd significantly less frequently than from either control. M. canis was tested both individually and in groups and, when alone, fed less from Nd, however, in groups they fed significantly more often from Nd. These results confirm variability in response to a lanthanide metal both across species and within a species in the presence of competition. Since observed differences are not due to differences in sensitivity, other factors appear to influence behavioral responses and may compromise the effectiveness of lanthanide metals for the reduction of shark bycatch.

Webbadress https://www.sciencedirect.com/science/article/pii/S0022098111004266

Publikation Journal of Experimental Marine Biology and Ecology

Datum December 1, 2011

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.jembe.2011.09.016

How Close is too Close? The Effect of a Non-Lethal Electric Shark Deterrent on White Shark Behaviour

Typ Tidskriftsartikel

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Författare Shaun P. Collin

Sammanfattning: Sharks play a vital role in the health of marine ecosystems, but the potential threat that sharks pose to humans is a reminder of our vulnerability when entering the ocean. Personal shark deterrents are being marketed as the solution to mitigate the threat that sharks pose. However, the effectiveness claims of many personal deterrents are based on our knowledge of shark sensory biology rather than robust testing of the devices themselves, as most have not been subjected to independent scientific studies. Therefore, there is a clear need for thorough testing of commercially available shark deterrents to provide the public with recommendations of their effectiveness. Using a modified stereo-camera system, we quantified behavioural interactions between white sharks (Carcharodon carcharias) and a baited target in the presence of a commercially available, personal electric shark deterrent (Shark Shield Freedom7™). The stereo-camera system enabled an accurate assessment of the behavioural responses of C. carcharias when encountering a non-lethal electric field many times stronger than what they would naturally experience. Upon their first observed encounter, all C. carcharias were repelled at a mean (± std. error) proximity of 131 (± 10.3) cm, which corresponded to a mean voltage gradient of 9.7 (± 0.9) V/m. With each subsequent encounter, their proximity decreased by an average of 11.6 cm, which corresponded to an increase in tolerance to the electric field by an average of 2.6 (± 0.5) V/m per encounter. Despite the increase in tolerance, sharks continued to be deterred from

interacting for the duration of each trial when in the presence of an active Shark Shield™. Furthermore, the findings provide no support to the theory that electric deterrents attract sharks. The results of this study provide quantitative evidence of the effectiveness of a non-lethal electric shark deterrent, its influence on the behaviour of C. carcharias, and an accurate method for testing other shark deterrent technologies.

Webbadress https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157717

Publikation PLOS ONE

Datum 1 juli 2016

Språk en

Bibliotekskatalog PLoS Journals

DOI 10.1371/journal.pone.0157717

Lanthanide metals as potential shark deterrents

Typ Uppsats

Författare Sara McCutcheon

Sammanfattning: Sharks comprise a large portion of bycatch in pelagic longline fisheries worldwide. Lanthanide metals have been proposed as shark repellents. This study quantified the normalized voltage of lanthanide metals in seawater and found that there was no difference in normalized voltage among the six tested metals. Temperature and salinity had a significant effect on lanthanide normalized voltage. The output at 18ºC was significantly greater than at both 12 and 24ºC. The normalized voltage was significantly greater in freshwater than brackish or seawater. The dissolution rate for the lanthanides varied from -1.6 to -0.2g/h. As the metals dissolved the voltage remained constant. In a behavioral assay, neodymium was ineffective at repelling bonnethead sharks (Sphyrna vtiburo) tested individually and in groups, and lemon sharks (Negaprion brevirostris) in groups. Due to high cost, fast dissolution rates, and lack of deterrent effects, lanthanide metals are not recommended for use in mitigating shark bycatch.

Webbadress https://www.proquest.com/openview/2074d2457de52b7c7809044b2430f554/1?cbl=18750&parentSessionId=d7kgUCrZmR7DfRO7Ef%2FbKMtsKDbziiUutbplqa5F%2FGk%3D&pq-origsite=gscholar&accountid=28676

Datum May 2012

Ort Boca Raton

Språk en

Electrochemical properties of lanthanide metals in relation to their application as shark repellents

Typ Tidskriftsartikel

Författare Sara M. McCutcheon

Författare Stephen M. Kajiura

Sammanfattning: Sharks comprise a large portion of unwanted bycatch in longline fisheries worldwide and various technologies have been proposed to reduce elasmobranch bycatch without impacting the catch of target species. Recently, the naturally electrogenic lanthanide metals have been introduced as an elasmobranch-specific repellent. We quantified the voltage produced by six lanthanide metals in seawater, compared their dissolution rates, and performed a behavioral assay to determine their efficacy against two coastal shark species. We found that there was no difference in the voltage produced by the six tested metals and the voltage decayed as a power function (approximately x−1.5) with distance from the metal sample. We calculated that sharks should detect a sample of neodymium from a distance of 65–85cm in seawater. Voltage was greatest in freshwater and decreased logarithmically with increasing salinity but did not differ above salinities greater than 10ppt. The dissolution rate for the lanthanides varied from −1.6 to −0.2gh−1 and as the metals dissolved, the voltage remained constant. In a behavioral assay, neodymium was ineffective at repelling bonnethead sharks (Sphyrna tiburo) tested individually and in groups, and juvenile lemon sharks (Negaprion brevirostris) in groups.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783613001318

Publikation Fisheries Research

Datum October 1, 2013

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2013.04.014

Effects of the SMART™ (Selective Magnetic and Repellent-Treated) hook on spiny dogfish catch in a longline experiment in the Gulf of Maine

Typ Tidskriftsartikel

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Författare Pingguo He

Författare Jason Joyce

Författare Eric M. Stroud

Författare Patrick H. Rice

Sammanfattning: The spiny dogfish, Squalus acanthias, is viewed as a nuisance species due to their high abundance in the western Atlantic, in addition to their seemingly overwhelming presence on a variety of commercial fishing gears. In the present study, we incorporated two types of potential elasmobranch repellents, an (1) electropositive metal and (2) magnetism, which were combined on a fishing hook – the SMART (Selective Magnetic and Repellent-Treated) hook and tested on S. acanthias in the Gulf of Maine. Results obtained after 26 days of longline gear deployment demonstrated that SMART hooks decreased S. acanthias capture by 28.2%; however, SMART hooks had no observed influence on thorny skate (Amblyraja radiata), barndoor skate (Dipturus laevis), and teleost capture. Of the S. acanthias captured, a total of 120 were kept for dissection and S. acanthias captured on controls were found to have significantly higher levels of satiation compared to sharks captured on treatments. Lastly, laboratory analyses demonstrated that SMART hooks produced a mean voltage of 1.05 eV for a duration of 5 days, which thereafter the metal quickly dissolved and the voltage dissipated. In conclusion, the use of the SMART hook may not be economically feasible in this fishery, as the relative target catch (e.g. teleosts) did not offset the cost of the hooks; however, this study suggests SMART hooks as a potentially promising means to increase

selectivity of hook gear and reduce S. acanthias capture and therefore future research in other fisheries is warranted.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569112002116

Publikation Ocean & Coastal Management

Bokserie Shark Defense

Datum August 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2012.08.002

Behavioral modification of visually deprived lemon sharks (Negaprion brevirostris) towards magnetic fields

Typ Tidskriftsartikel

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Författare T. L. Guttridge

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Författare P. He

Sammanfattning: The ability of elasmobranchs to orient to weak electromagnetic fields is well documented. Recently, scientists have employed the use of strong electrosensory stimuli, such as permanent magnets, as a means to evaluate the repellent responses of elasmobranchs and assess the utility of these materials for bycatch repellent technologies. However, several studies have produced contrasting results both between and within species. To explain these results, we hypothesized that conditions leading to vision loss (i.e. turbid water) may be a factor affecting

electrosensory repellent success. To simulate a visually deprived environment, the nictitating membranes of juvenile lemon sharks (Negaprion brevirostris) were temporarily sutured closed and the behavioral responses of sharks towards a magnetic apparatus were observed in a pen within the shallows of Bimini, Bahamas. Results demonstrate that the magnet-associated behavior of visually deprived sharks significantly differed from control sharks in regard to: (1) avoidance distance, (2) visit quantity prior to first entrance through the magnet zone, and (3) total entrances/total visits. These findings suggest context-dependent switching, where elasmobranchs may exhibit a heightened reliance on their electrosensory system when the extent of their visual range is reduced. These findings also provide insight into favorable environments (e.g. estuary or other coastal ecosystems) and applications (e.g. inshore fisheries and beach nets) that may yield more consistent and successful future implementations of electrosensory repellents for sharks.

Webbadress https://www.sciencedirect.com/science/article/pii/S0022098114000100

Publikation Journal of Experimental Marine Biology and Ecology

Datum April 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.jembe.2014.01.009

Analysis of permanent magnets as elasmobranch bycatch reduction devices in hook-and-line and longline trials

Typ Tidskriftsartikel

Författare Craig P. O'Connell

Författare Daniel C. Abel

Författare Eric M. Stroud

Författare Patrick H. Rice

Sammanfattning: Previous studies indicate that elasmobranch fishes (sharks, skates and rays) detect the Earth’s geomagnetic field by indirect magnetoreception

through electromagneticinduction, using their ampullae of Lorenzini. Applying this concept, we evaluated the capture of elasmobranchs in the presence of permanent magnets in hook-and-line and inshorelongline fishing experiments. Hooks with neodymium-iron-boron magnets significantly reduced the capture ofelasmobranchs overall in comparison with control and procedural control hooks in the hook-and-line experiment.Catches of Atlantic sharpnose shark (Rhizoprionodon terraenovae) and smooth dogfish (Mustelus canis) were signif icantly reduced with magnetic hook-and-line treatments, whereas catches of spiny dogfish (Squalus acanthias) and clearnose skate (Raja eglanteria) were not.Longline hooks with barium-ferrite magnets significantly reduced total elasmobranch capture when compared with control hooks. In the longline study, capture of blacktip sharks (Carcharhinus limbatus) and southern stingrays (Dasyatis americana) was reduced on magnetic hooks, whereascapture of sandbar shark (Carcharhinus plumbeus) was not affected. Teleosts, such as red drum (Sciaenops ocellatus), Atlantic croaker (Micropogonias undulatus), oyster toadfish(Opsanus tau), black sea bass (Centropristis striata), and the bluefish (Pomatomas saltatrix), showed no hook preference in either hook-and-line or longline studies. These results indicate that permanent magnets, although eliciting species-specific capture trends, warrant further investigation in commercial longline and recreational fisheries, where bycatch mortality is a leading contributor to declines in elasmobranch populations.

Webbadress https://aquadocs.org/handle/1834/25349

Publikation http://aquaticcommons.org/id/eprint/8699

Datum 2011

Språk en

Bibliotekskatalog aquadocs.org

A large scale field analysis examining the effect of magnetically-treated baits and barriers on teleost and elasmobranch behavior

Typ Tidskriftsartikel

Författare C. P. O'Connell

Författare P. He

Sammanfattning: Recent studies have demonstrated that elasmobranchs (i.e. sharks, skates and rays) are sensitive and often deterred by electrosensory stimuli (e.g. permanent magnets and electropositive metals). These studies have, however,

produced mixed results; but due to the importance of reducing elasmobranch bycatch in fisheries and/or directed shark capture in beach nets, future research on electrosensory repellents is imperative. At the same time, understanding the potential influence of these materials on other marine animals is equally important so that the techniques may be selectively applied to achieve conservation goals while having little impact on non-target species. In the present study, both bait and barrier experiments were conducted in the Bahamas to assess how barium-ferrite (BaFe12O19) permanent magnets might influence teleost and elasmobranch behavior. For both the bait and barrier experiments, teleost species exhibited no significant associations between behavior and treatment type. Furthermore, elasmobranchs exhibited significant behavioral variation towards magnetically-treated baits, in comparison to baited controls and procedural controls. However, during the barrier experiment blacknose sharks (Carcharhinus acronotus) and southern stingrays (Dasyatis americana) exhibited no significant behavioral changes to magnetically-treated barrier regions, whereas Caribbean reef (Carcharhinus perezi) and nurse (Ginglymostoma cirratum) sharks did. This study is the first large-scale analysis of teleost behavior around magnetically-treated baits and barriers, and provides further support to the hypothesis suggesting that electrosensory repellents target and observably alter the behavior of aquatic organisms containing electroreceptors. In addition, the species-specificity of elasmobranch responses which occurred during the barrier experiment provides valuable information for future conservation engineering applications in fishing gears and beach nets.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569114001598

Publikation Ocean & Coastal Management

Datum August 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2014.05.011

Response of juvenile lemon sharks, *Negaprion brevirostris*, to a magnetic barrier simulating a beach net

Typ Tidskriftsartikel

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Författare Daniel C. Abel

Författare Samuel H. Gruber

Författare Eric M. Stroud

Författare Patrick H. Rice

Sammanfattning: Beach nets are preventative devices used to minimize interactions between potentially harmful sharks and unsuspecting swimmers. Quantitative studies demonstrated that beach nets drastically reduced local elasmobranch populations, as well as caused considerable bycatch mortality. For this experiment, a beach net-like device was constructed and the behaviors of six juvenile lemon sharks (Negaprion brevirostris) were analyzed. Induced by olfactory and gustatory cues, sharks were given the choice to swim through a magnetic or control opening in the net. In the first trial, all six sharks avoided the magnetic region and significantly preferred to swim through the control region of the fence. The magnetic stimulus no longer affected the swimming behavior of three sharks retested after resting 24 h. Results from the retested sharks were correlated with those from repeated tonic immobility trials, which demonstrated a linear decrease in sensitivity to repeated magnetic stimulation. This study serves as a baseline experiment demonstrating that permanent magnets may substantially decrease elasmobranch mortality within beach nets.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569110001997

Publikation Ocean & Coastal Management

Datum March 1, 2011

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2010.11.006

Responses of the southern stingray (*Dasyatis americana*) and the nurse shark (*Ginglymostoma cirratum*) to permanent magnets

Typ Tidskriftsartikel

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Sammanfattning: The behavioral responses of free-swimming, wild southern stingrays (Dasyatis americana) and nurse sharks (Ginglymostoma cirratum) to permanent magnets were evaluated in the Florida Keys, USA. Animals were attracted to a baited magnetic treatment board consisting of two 15 cm × 10 cm × 5 cm grade C8 Barium-Ferrite (empirically, BaFe12O19) permanent magnets producing a flux of 950 gauss at their surface and a baited procedural control board containing two smooth nonmagnetized clay bricks. In the presence of permanent magnets, D. americana and G. cirratum demonstrated a significantly greater number of avoidance behaviors away from the magnet side of the apparatus, while both species fed a significantly greater number of times from the non-magnetized procedural control side. Thus, D. americana and G. cirratum showed sensitivity to a magnetic field and were successfully repelled from baited areas containing magnets. The results from the current study suggest that the use of grade C8 Barium-Ferrite permanent magnets as an avoidance mechanism (e.g., repellent) to reduce elasmobranch mortalities associated with fishing operations and beach nets merits further investigation.

Webbadress https://doi.org/10.1080/10236241003672230

Publikation Marine and Freshwater Behaviour and Physiology

Datum January 1, 2010

Bibliotekskatalog Taylor and Francis+NEJM

DOI 10.1080/10236241003672230

Effects of barium-ferrite permanent magnets on great hammerhead shark *Sphyrna mokarran* behavior and implications for future conservation technologies

Typ Tidskriftsartikel

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Sammanfattning: The great hammerhead shark Sphyrna mokarran is an endangered species that is exposed to several sources of anthropogenic mortality, including beach nets. Although not a major contributor to S. mokarran mortality, beach nets are utilized in several locations to minimize the potential harmful interaction between sharks and beachgoers. To address this mortality, permanent magnets have been employed to determine if these materials can deter sharks away from netted areas. The present study examined the effects of barium-ferrite (BaFe12O19) permanent magnets on S. mokarran behavior under several environmental and biological conditions. In the bait experiment, feeding frequency significantly decreased and avoidance frequency significantly increased with the magnet treatment, with exposure quantity yielding an increase in feeding frequency, although this effect was not statistically significant. For the barrier experiment, entrance frequency significantly decreased and avoidance and pass-around frequencies significantly increased with the magnet treatment, with heterospecific density also being a significant predictor of entrance frequency. The findings demonstrate how permanent magnets can modify S. mokarran behavior and how this behavior is modified based on situational context. Since several other sphyrnid species are caught in beach nets more frequently than S. mokarran (e.g. scalloped hammerheads S. lewini), the present results may serve as a model for these other sphyrnid species and illustrate the potential conservation implications of future magnetic deterrent barrier technologies.

Webbadress https://www.int-res.com/abstracts/esr/v26/n3/p243-256/

Publikation Endangered Species Research

Datum 2015-01-22

Språk en

Bibliotekskatalog www.int-res.com

DOI 10.3354/esr00629

Reducing longline bycatch: The larger the hook, the fewer the stingrays

Typ Tidskriftsartikel

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Sammanfattning: Chondrichthyan populations in the Mediterranean Sea have been heavily affected by the impact of fishing activities. In the last two decades, even fishing gears that were traditionally considered highly selective, such as pelagic longlines, have been revealed to be responsible for the capture of many unwanted species. The pelagic stingray (Pteroplatytrygon violacea) is not an endangered nor a charismatic species, but it largely dominates longlines bycatch fractions. The aim of our study was to investigate the importance of three main variables, bait size, presence and type of light attractors, and hook size and shape, in the capture rate of pelagic stingrays. Ninety-seven longline experimental sets were run. Trials took place on nine vessels in the Strait of Sicily, central Mediterranean Sea, over a period of 3years from 2005 to 2007. Results showed that the larger the J hook, the lower the stingray capture rate. Moreover, 16/0 circle hooks had a significantly lower number of stingrays captured per 1000 hooks than J hooks, up to ∼80%. Bait size, within the range of sizes assessed, and use of light attractors did not have significant effects on stingray catch rate. These results suggest that the adoption of large circle hooks by commercial and artisanal swordfish longlining may be a measure to reduce their environmental footprint.

Webbadress https://www.sciencedirect.com/science/article/pii/S0006320709004388

Publikation Biological Conservation

Datum January 1, 2010

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.biocon.2009.10.001

Behavioural responses in the sand tiger shark (*Carcharias taurus*) to permanent magnets and pulsed magnetic fields

Typ Tidskriftsartikel

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Sammanfattning: Sharks are threatened by several human activities that impact their distribution and abundance. A great proportion of shark captures happen as incidental capture (bycatch) by fisheries and in beach nets. Recent studies have focused on reducing these captures by exploiting technologies that target the sharks' electrosensory system, obtaining contrasting results. This study investigates the effect of a strong neodymium magnet and pulsed magnetic fields (PMFs) on captive sand tiger sharks (Carcharias taurus) through the analysis of their behavioural responses. Firstly, individuals were presented with the magnet in combination with different types of food. The magnet did not influence the sharks' behaviours, while an effect of the food type emerged. Secondly, PMFs were generated through a pulsed electric current induced within a solenoid associated with a PVC structure. The PMFs affected some of the sharks' behaviours, both near (<2 m) and at a distance (>2 m) from the source. The results suggest that strong magnets are inefficient in deterring sand tiger sharks, while PMFs could be a promising alternative. This study confirms how the efficacy of shark repellents may be affected by factors such as the type of electrosensory stimuli, the species involved, and the context in which the interaction takes place.

Webbadress https://doi.org/10.1080/17451000.2021.1887496

Publikation Marine Biology Research

Datum January 2, 2021

Bibliotekskatalog Taylor and Francis+NEJM

DOI 10.1080/17451000.2021.1887496

Hooks equipped with magnets can increase catches of blue shark (*Prionace glauca*) by longline fishery

Typ Tidskriftsartikel

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Sammanfattning: Blue shark (Prionace glauca) populations are decreasing worldwide and the species is currently classified as near threatened. However, it is the main species caught by the Spanish and Portuguese longline fisheries; and blue shark is specifically targeted by a part of these fleets in the northeastern Atlantic Ocean. Sharks are well known to be able to detect electric fields in the microvolt range and this sense has been proposed to provide a mechanism to detect the earth's magnetic field. As a result, the use of magnets has been proposed as a method to reduce shark interactions with fishing gear. We therefore tested two models of high field strength neodymium magnets to effect shark catch rates during commercial longline fishing operations. Our results show that magnets do not reduce blue shark catch rates and can even have an attractive effect. This effect was significantly higher for the larger magnet model tested (26mm×11mm×12mm, 0.885T) compared to the smaller one (20mm×13mm×15mm, 0.464T). We also noted that hooks remain magnetized after removal of the magnets and are even slightly magnetized without any previous contact with a magnet.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783615300254

Publikation Fisheries Research

Datum December 1, 2015

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2015.07.016

Permanent magnets reduce bycatch of benthic sharks in an ocean trap fishery

Typ Tidskriftsartikel

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Sammanfattning: Sharks and rays are often caught as bycatch by commercial fisheries, and high incidences of bycatch are partially to blame for the declines in many populations of elasmobranchs. In an effort to reduce rates of bycatch, researchers have tested various deterrents that could benefit fisheries. Permanent magnets are one promising form of bycatch reduction device, yet their efficacy has only been tested for hook-and-line fisheries with variable results. Here, we examined the potential benefits of permanent magnets on an ocean fish trap fishery targeting snapper (Pagrus auratus) where more than 10% of the total catch is comprised of unwanted elasmobranchs and the presence of elasmobranchs reduces the catch of target species. Over 1000 fish traps were deployed in a fishery-dependent survey in New South Wales, Australia. Standardised catch rates indicate that the incorporation of magnets into fish traps significantly reduced incidences of elasmobranch bycatch (mainly Brachaelurus waddi) by over a third, while increasing the amount of target fish caught by an equivalent amount. Together these results suggest that magnets can be used as an effective bycatch reduction device that reduces incidences of elasmobranch bycatch while increasing the profitability of fish traps for fishermen. Future studies should aim to replicate these results in areas where different species of elasmobranchs occur.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783618301966

Publikation Fisheries Research

Datum December 1, 2018

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2018.07.006

Assessment of permanent magnets and electropositive metals to reduce the line-based capture of Galapagos sharks, *Carcharhinus galapagensis*

Typ Tidskriftsartikel

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Sammanfattning; Sharks possess anterior electrosensory pores (ampullae of Lorenzini), which allow them to detect very weak electromagnetic fields. Powerful magnetic fields may overwhelm this sense, and repel sharks, even in the presence of an attractant. Using underwater video, we tested seven rare earth magnet configurations, two ferrite magnet configurations and two rare earth electropositive metals as means to reduce the rate at which Galapagos sharks (Carcharhinus galapagensis) depredated baited lines. Configurations of three 50mm diameter rare earth magnet discs showed the most potential, with a vertical configuration of magnets alongside the bait reducing depredation by 50%, and a stacked configuration of the same magnets above the bait also producing significantly more aborted investigations of the bait prior to depredation. No other magnetic or electropositive metal configuration produced significant reductions in depredation rates, time taken to strike, or number of prior investigations. Our study showed that the overriding factor determining Galapagos shark behaviours towards baits was conspecific density. The number of sharks present increased as trials progressed, with a corresponding decrease in their time to depredate baits. This effect was particularly apparent when three or more animals were present. These higher shark densities diminished the effectiveness of our experiments as individuals engaged in non-selective “mob” rushes towards the closest bait. Although our results showed that social interactions between sharks outweighed individual responses to depredation-mitigation devices, magnetic deterrents have high potential for reducing shark bycatch for species that occur in lower densities, or which interact less vigorously with conspecifics than Galapagos sharks.

Webbadress

https://www.sciencedirect.com/science/article/pii/S01657836110004

27

Publikation Fisheries Research

Datum April 1, 2011

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2011.01.023

Effects of auditory and visual stimuli on shark feeding behaviour: the disco effect

Typ Tidskriftsartikel

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Författare Nathan S. Hart

Sammanfattning: Sensory systems play a central role in guiding animal behaviour. They can be manipulated to alter behavioural outcomes to limit negative

interactions between humans and animals. Sharks are often seen as a threat to humans and there has been increasing interest in developing shark mitigation devices. Previous research has concentrated on stimulating the electrosensory and olfactory systems of sharks, whereas the infuence of light and sound on their behaviour has received little attention. In this study, the efects of an intense strobe light and a loud, artifcial sound composed of mixed frequencies and intensities on shark behaviour were assessed. We tested these stimuli individually and in combination on wild-caught captive Port Jackson (Heterodontus portusjacksoni) and epaulette (Hemiscyllium ocellatum) sharks in aquaria and on wild great white sharks (Carcharodon carcharias) in the feld. When presented alone and in combination with sound, the lights reduced the number of times that the bait was taken by both H. portusjacksoni and H. ocellatum in captivity. The strobe light alone, however, did not afect the behaviour of white sharks, but when presented in combination with sound, white sharks spent signifcantly less time in proximity to the bait. As the lights and sound presented in this study did not show a pronounced deterrent efect on C. carcharias, we do not advise their use as a strategy for mitigating shark–human interactions. However, due to the potential efectiveness of strobe lights in deterring other species of sharks, there may be applications for this approach in the reduction of fsheries bycatch.

Webbadress http://link.springer.com/10.1007/s00227-017-3256-0

Publikation Marine Biology

Datum 1/2018

Språk en

Bibliotekskatalog DOI.org (Crossref)

DOI 10.1007/s00227-017-3256-0

The effects of neodymium-iron-boron permanent magnets on the behaviour of the small spotted catshark (*Scyliorhinus canicula*) and the thornback skate (*Raja clavata*)

Typ Tidskriftsartikel

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Författare Craig P. O'Connell

Sammanfattning: Elasmobranchs (sharks, skates, and rays) are frequently captured as bycatch on a wide variety of fishing gears, such as pelagic longlines and hook-and-line fisheries, and therefore many species have experienced severe population declines. To reduce elasmobranch bycatch, scientists have begun exploring the effectiveness and potential application of elasmobranch-specific repellents, such as permanent magnets and electropositive metals. For the present study, the behavioural responses of captive small spotted catsharks (Scyliorhinus canicula) and thornback skates (Raja clavata) were observed in response to neodymium-iron-boron (Nd2Fe14B) permanent magnets. Results demonstrate that both R. clavata and S. canicula; (1) significantly avoided the Nd2Fe14B magnets more often in comparison to the control and procedural control and (2) significantly fed from the control and procedural control more often in comparison to the Nd2Fe14B magnets. Data also suggests a relationship between water temperature and the avoidance distance by R. clavata, with closer approaches prior to avoidance occurring in association with water temperatures of ≤12 °C. Additionally, the tail beat frequency associated with the avoidance behaviour of S. canicula was significantly slower (≤9 beats/10 s) in water temperatures of ≤12 °C. The findings from this study agree with previous electrosensory repellent studies, in that elasmobranchs detect and are deterred by permanent magnets however, the present study also demonstrated that there is a correlation between avoidance speed and distance with water temperature. These findings suggest that water temperature may be correlated to magnetic repellent effectiveness and thus warrants further experimentation.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569113001452

Publikation Ocean & Coastal Management

Bokserie Shark Defense

Datum August 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2013.05.010

Trialling innovative disruptive technology to reduce bycatch in the Isle of Man queen scallop (*Aequipecten opercularis*) trawl fishery

Typ Uppsats

Författare Lucy Southworth

Sammanfattning: In the Isle of Man queen scallop fishery, bycatch species such as haddock cod and whiting have the potential to choke the fishery once the EU landings obligation is enforced in 2019. This study provides evidence that target catch can be maintained while reducing bycatch species. Commercial trials to develop species-selective trawl gear were conducted using a paired tow design whereby a control net is towed parallel to a treatment net with either: 1) a square mesh panel or; 2) a square mesh panel incorporating six white LED lights inserted into a traditional all diamond mesh otter trawl. The square mesh panel was found to be most effective in medium depths (29-40m) with high ambient light levels, significantly reducing lesser spotted catshark by 34% (P= 0.004) and whiting by 82% (P=0.008). While in these depths the net with both the panel and the lights observed reductions of whiting bycatch by 77% (P=0.01) and haddock by 55% (P=0.06). The panel plus lights in deep water (45-95m) with low ambient light levels, reduced bycatch of lesser spotted catshark by 48% (P= 0.04), flatfish by 26% (P=0.002) and haddock by 55% (P=0.001). Water depth was found to have a significant influence on the effectiveness of the devices to reduce bycatch of haddock (P=0.004). Strong but opposite linear relationships of haddock bycatch were detected between the two treatments with increasing depth. The square mesh panel incurred increases of haddock bycatch, while substantial reductions occurred with the addition of lights to the panel in deeper waters (P=0.005). However, no reductions of cod bycatch were observed in either treatment. These results indicate the importance of understanding species-specific responses to bycatch reduction devices and that determining the influence environmental parameters have on species catchability is key to establishing appropriate technical modifications to reduce bycatch.

Datum October 2017

Språk en

Bibliotekskatalog Zotero

Chemical shark repellent: Myth or fact? The effect of a shark necromone on shark feeding behavior

Typ Tidskriftsartikel

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Sammanfattning: Since 1942, the search for an effective chemical shark repellent has been ongoing research concern in the United States. A long-standing anecdote that sharks avoid areas containing decomposing shark tissue has initiated new interest in identifying trace chemical alarm signals produced during decomposition (necromones). A commercially-sourced shark necromone produced from putrefied shark tissue was evaluated over a five-year period in South Bimini, Bahamas. Competitively-feeding populations of Caribbean reef sharks (Carcharhinus perezi) and blacknose sharks (Carcharhinus acronotus) were exposed to necromones using pressurized aerosol canisters at the surface. Shark density estimations were made at the initial, 1 min and 5 min intervals after preliminary exposure along with continuous exposure of feeding stimulus. In both species, an unambiguous halt in feeding behavior was observed within 1 min after exposure of the necromone. For aerosol delivery, a 150 mL dose of the necromone from a single aerosol canister is able to halt all feeding activity in a combined population of C. perezi and C. acronotus. Shark necromones induced a spectacular alarm response in interacting sharks resulting in a temporary evacuation of an area containing feeding stimuli. Additionally, sharks were not deterred by alternative treatment presentations of 10% weight percent (w/w) aqueous urea, 10% w/w oleic acid in ethanol, or water buffered to pH 8.5. Habituation to the necromone was not observed for repeated tests at the same location. In all experiments, the presence of a shark necromone did not produce a similar aversion response for teleosts as observed in C. perezi or C. acronotus; however, anecdotal observations demonstrate that teleosts increased their feeding rate in the presence of the necromone. Experimental controls using denatured ethanol or water confirmed that feeding sharks were not deterred by bubbles, sound, or the solvents used to extract the necromones. Comprehensive two-dimensional gas chromatography coupled to time-of-flight mass spectrometry indicates that the necromone is a complex solution rich in amino acids and putrefaction products. Experiments demonstrate that the key chemical component responsible for the alarm response is within these amino acids and/or putrefaction products, but further experimentation is needed to more accurately identify the active ingredient. Shark necromones hold particular promise for use in shark bycatch reduction and conservation. The existence of a putative chemical shark repellent has been confirmed.

Webbadress https://www.sciencedirect.com/science/article/pii/S0964569113000161

Publikation Ocean & Coastal Management

Bokserie Shark Defense

Datum August 1, 2014

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.ocecoaman.2013.01.006

Behavioural responses of draughtboard sharks (Cephaloscyllium laticeps) to rare earth magnets: Implications for shark bycatch management within the Tasmanian southern rock lobster fishery

Typ Tidskriftsartikel

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Författare Mike Williams

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Sammanfattning: Catches of draughtboard shark (Cephaloscyllium laticeps) in the Tasmanian Southern Rock Lobster Fishery are considered an economic and potentially ecological issue. Consequently, there is interest in developing strategies to mitigate and minimise shark bycatch within this fishery. This field study examined the behavioural responses of draughtboard sharks to neodymium-iron-boron (Nd2Fe14B) rare earth magnetic rods attached to baited video apparatus. Two magnetic treatments and one control were used in 12 × 1.5 h observational trials conducted in inshore waters of Tasmania, Australia. Results demonstrate that draughtboard sharks: (1) showed substantial individual variation in behaviours both between and within treatments, with no patterns of individual responses observed over time to both magnetic treatments or the control, (2) showed significant differences in initial interactions between the magnetic treatments and the control, and (3) attempted to take bait at the control significantly more often than at the 2-magnet treatment. These findings demonstrate the individualistic and highly

variable response behaviours of draughtboard sharks to rare earth magnets. Understanding such behaviours may facilitate the development of effective deterrent strategies in this fishery and improve management of shark-fishery interactions globally.

Webbadress https://www.sciencedirect.com/science/article/pii/S0165783618300018

Publikation Fisheries Research

Datum April 1, 2018

Språk en

Bibliotekskatalog ScienceDirect

DOI 10.1016/j.fishres.2018.01.001