

# **Killer whale photographic-identification catalogue for the Tallurutiup Imanga National Marine Conservation Area and Cumberland Sound, 2009-2020**

Caila E. Kucheravy, Kyle J. Lefort, Cory J.D. Matthews, Stephen D. Petersen, Jeff W. Higdon, Steven H. Ferguson

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2023

**Canadian Technical Report of  
Fisheries and Aquatic Sciences 3564**



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by

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Department of Fisheries and Oceans, 2023.

Cat. No. Fs97-6/3564E-PDF

ISBN 978-0-660-67929-7

ISSN 1488-5379

Correct citation for this publication:

Kucheravy, C.E., Lefort, K.J., Matthews, C.J.D., Petersen, S.D., Higdon, J.W. and Ferguson, S.H. 2023. Killer whale photographic-identification catalogue for the Tallurutiup Imanga National Marine Conservation Area and Cumberland Sound, 2009-2020. Can. Tech. Rep. Fish. Aquat. Sci. 3564: v + 58 p.

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## ABSTRACT

Kucheravy, C.E., Lefort, K.J., Matthews, C.J.D., Petersen, S.D., Higdon, J.W. and Ferguson, S.H. 2023. Killer whale photographic-identification catalogue for the Tallurutiup Imanga National Marine Conservation Area and Cumberland Sound, 2009-2020. Can. Tech. Rep. Fish. Aquat. Sci. 3564: v + 58 p.

Photographic identification is an important tool for the study of many marine mammal species, and has been used to document populations of killer whales (*Orcinus orca*) around the globe since the 1970s. Distinct features on the dorsal fin and saddle patch allow for the identification of individual killer whales, leading to a better understanding of the species' abundance, distribution, and ecology. In the eastern Canadian Arctic, killer whale presence appears to be increasing during the ice-free season. The number of killer whales seasonally present in the Northern Baffin Island region was estimated to be  $163 \pm 27$  based on mark-recapture analysis of 63 individuals identified in photographs collected from 2009-2018. In this report, we provide an updated photo-identification catalogue of killer whales photographed between 2009-2020 in and around the Tallurutiup Imanga National Marine Conservation Area (primarily in the waters surrounding northern Baffin Island) and Cumberland Sound, Nunavut. We identify 94 killer whales in and around the Tallurutiup Imanga National Marine Conservation Area and eight individuals in Cumberland Sound, and report the photographic sightings history of each individual identified.

## RÉSUMÉ

Kucheravy, C.E., Lefort, K.J., Matthews, C.J.D., Petersen, S.D., Higdon, J.W. and Ferguson, S.H. 2023. Killer whale photographic-identification catalogue for the Tallurutiup Imanga National Marine Conservation Area and Cumberland Sound, 2009-2020. Can. Tech. Rep. Fish. Aquat. Sci. 3564: v + 58 p.

L'identification photographique, un outil important pour l'étude de nombreuses espèces de mammifères marins, est utilisée pour documenter des populations d'épaulard (*Orcinus orca*) partout sur la planète depuis les années 1970. Il est possible d'identifier les individus à l'aide des caractéristiques uniques de leur nageoire dorsale et de leur tache en forme de selle et d'ainsi mieux comprendre l'abondance, la répartition et l'écologie de l'espèce. Dans l'est de l'Arctique canadien, l'épaulard semble de plus en plus présent pendant la saison libre de glace. Le nombre d'épaulards présents de façon saisonnière dans la région du nord de l'île de Baffin a été estimé à  $163 \pm 27$  d'après l'analyse par marquage-recapture de 63 individus identifiés au moyen de photographies prises entre 2009 et 2018. Dans le présent rapport, nous fournissons un catalogue de photo-identification actualisé qui comprend des épaulards photographiés entre 2009 et 2020 dans l'aire marine nationale de conservation Tallurutiup Imanga et ses environs (principalement dans les eaux entourant le nord de l'île de Baffin) et dans la baie de Cumberland, au Nunavut. Nous identifions 94 épaulards présents dans l'aire marine nationale de conservation Tallurutiup Imanga et ses environs et huit épaulards présents dans le détroit de Cumberland, et fournissons l'historique des photographies prises pour chaque individu identifié.

## 1. INTRODUCTION

Photographic identification (photo-ID) of killer whales (*Orcinus orca*) began in the early 1970s when Dr. Michael Bigg and colleagues in British Columbia, Canada determined that individual whales could be identified from photographs by the shapes of their dorsal fins and distinct markings on their saddle patches (Bigg 1982). Since then, photo-ID has become a valuable tool for the study of killer whales worldwide, providing researchers with a detailed understanding of killer whale life history, social structure, demography, distribution, and movement (e.g., Bigg et al. 1990; Olesiuk et al. 1990; Ford 1991; Dahlheim et al. 2008).

Killer whales have been sighted in the eastern Canadian Arctic during the open-water season since the mid-1800s (Reeves and Mitchell 1988). The frequency of sightings has increased significantly in the last several decades, suggesting that killer whale presence in this region may be growing (Higdon et al. 2012; 2014). Killer whales in the eastern Canadian Arctic appear to be ice-avoidant, and an increased presence may be associated with the increased duration of the ice-free season (Higdon and Ferguson 2009; Matthews et al. 2011; Higdon et al. 2012). However, the increase in sightings may also be related to increased effort (Higdon and Ferguson 2009) and the improved ability to capture photos and share them online.

Lancaster Sound, located in the eastern Canadian Arctic Archipelago, is rich in biodiversity and culturally important for Inuit communities in the region. It is also recognized internationally as an ecologically significant area (DFO 2011). Beginning in 2007, the Government of Canada and the Qikiqtani Inuit Association worked together to establish a National Marine Conservation Area (NMCA) in Lancaster Sound. In August 2019, the two parties signed an Inuit Impact and Benefit Agreement to establish the Tallurutiup Imanga NMCA. The southern portion of the NMCA includes the waters surrounding northern Baffin Island, where killer whales are frequently sighted during the open-water season. Killer whales are also regular summer visitors of Cumberland Sound, another biologically significant and resource-rich Arctic ecosystem (Higdon et al. 2012, DFO 2015). Found along southeastern Baffin Island, Cumberland Sound is home to two designated Ecologically and Biologically Significant Areas, Clearwater Fjord and Eastern Cumberland Sound (DFO 2015).

The number of killer whales that are seasonally resident in the northern Baffin Island region was estimated to be  $163 \pm 27$  individuals, based on capture-mark-recapture analysis of 63 individuals identified in photographs collected between 2009 and 2018 (Lefort et al. 2020a). There are currently no population estimates including individuals identified in Cumberland Sound. Based on observations, these whales feed primarily on narwhal (*Monodon monoceros*), beluga whales (*Delphinapterus leucas*), bowhead whales (*Balaena mysticetus*), and several phocid species (Ferguson et al. 2012; Higdon et al. 2012). Analysis of dietary biomarkers in the dentine collagen of



stranded killer whales in the eastern Canadian Arctic and Northwest Atlantic also suggest that these whales are primarily mammal-eating, but variation in isotopic values and tooth wear among individuals suggest that some may be fish-eating (Matthews et al. 2021). A greater killer whale presence is expected to impact the Arctic marine ecosystem through increased predation pressure and changes to prey behaviour (Breed et al. 2017; Lefort et al. 2020a; Matthews et al. 2020a).

The winter distribution and the annual movement patterns of these whales remain largely unknown, although satellite telemetry and the presence of epizoic barnacles on the dorsal fins of individuals suggest that at least some of the killer whales that visit Tallurutiup Imanga reside in warmer, possibly tropical, waters for parts of the year (Matthews et al. 2011; Matthews et al. 2020b). Details of group structure also remain unclear, and further research examining the population genetics, morphometrics, social structure, and distribution is needed to determine whether these whales constitute a single population or multiple distinct groups (Lefort et al. 2020b).

Photo ID of killer whales in the eastern Canadian Arctic began in 2004 (Young et al. 2011). A dedicated effort to collect photographs for research purposes has been ongoing since 2009 as part of the Orcas of the Canadian Arctic (OCA) research program within Fisheries and Oceans Canada (DFO). DFO has been fortunate to partner with Inuit community members who participate each year in fieldwork, as well as other contributors including cruise ship and tour operators. The purpose of this catalogue is to provide a resource for future research that will help improve our understanding of this population and answer questions about their demography, distribution, and social organization.

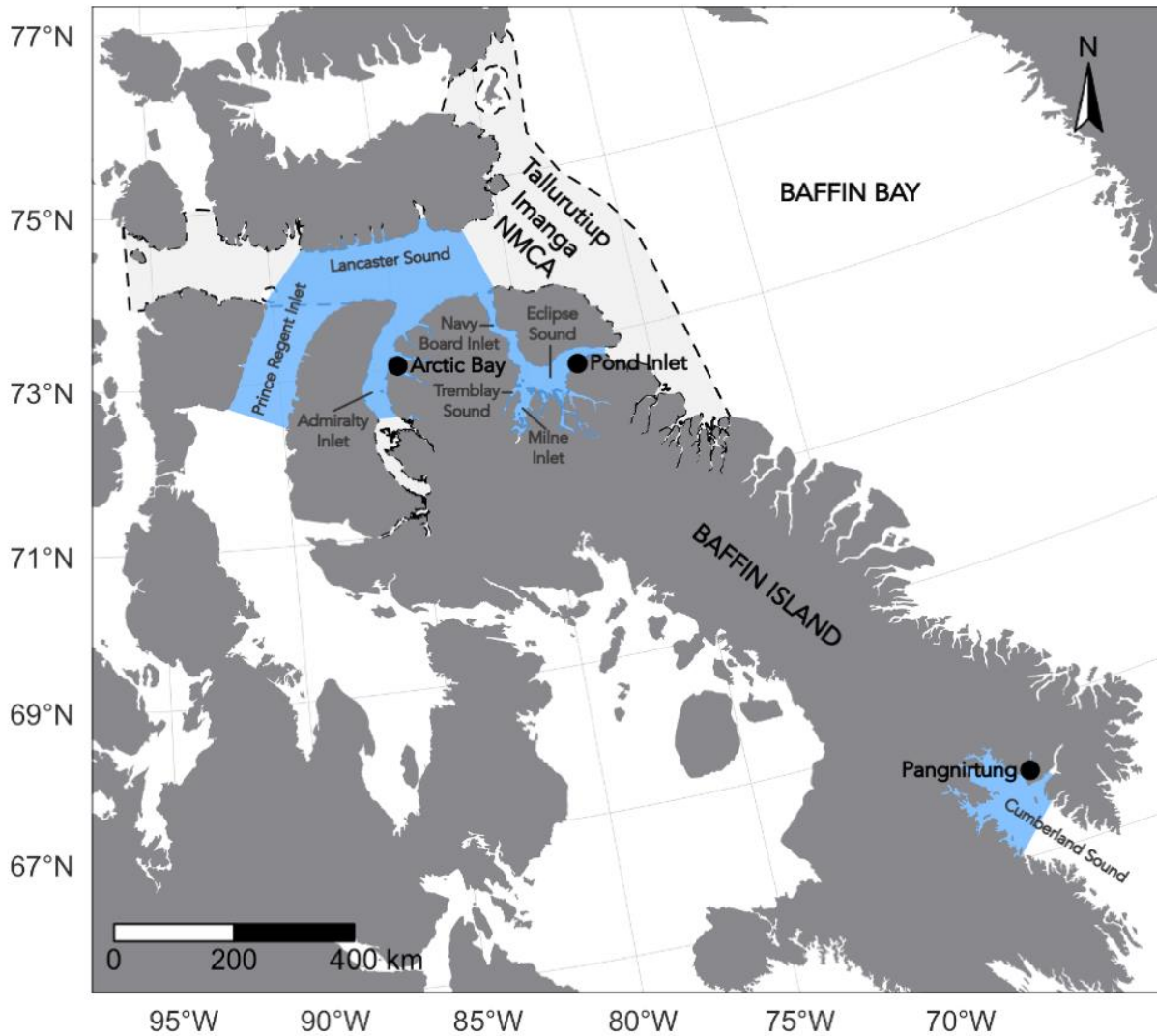
## **2. MATERIALS AND METHODS**

### **2.1 PHOTOGRAPH COLLECTION AND SAMPLING REGIONS**

This catalogue includes killer whales that were photographed in the Tallurutiup Imanga NMCA (and surrounding waters) and Cumberland Sound between 2009 and 2020. All photographs were taken in either August or September, during the ice-free season. Photographs were taken by photographers, researchers, and ecotourists, or contributed by Inuit community members. Upon sighting by researchers, groups of killer whales were approached by boat and as many photographs were taken as possible of the individuals in the group. Due to variation in the behaviour of killer whale groups (e.g. travelling), it was not always possible to photograph every individual in the group.

Photographs were taken in Eclipse Sound, Milne Inlet, Admiralty Inlet, Lancaster Sound, Prince Regent Inlet, Tremblay Sound, Navy Board Inlet, and Cumberland Sound (Figure 1, Table 1). Note that while many of the photographs were taken in the area now designated as the Tallurutiup Imanga NMCA, photo-identification efforts began prior to the establishment of the NMCA. The study area does not overlap with the entire

NMCA (see Figure 1), and thus some photographs were collected outside of the NMCA (e.g., in Prince Regent Inlet). Further, neither the NMCA nor the study areas represent the range of the population.



**Figure 1.** Map of the study areas (light blue), Tallurutiup Imanga National Marine Conservation Area (dashed outline), and nearby communities where photographs of killer whales were collected from 2009-2020. Tallurutiup Imanga NMCA shapefile obtained from the Canadian Protected and Conserved Areas Database (Government of Canada, 2023).

**Table 1.** Number of photographs in this document taken at each location in the Tallurutiup Imanga National Marine Conservation Area and in Cumberland Sound.

| Location         | Number of Photographs |      |
|------------------|-----------------------|------|
|                  | Right                 | Left |
| Eclipse Sound    | 54                    | 14   |
| Milne Inlet      | 20                    | 11   |
| Admiralty Inlet  | 15                    | 1    |
| Lancaster Sound  | 5                     | 2    |
| Tremblay Sound   | 1                     | 0    |
| Cumberland Sound | 8                     | 2    |

## 2.2 PHOTOGRAPHIC ANALYSIS

Photographs collected during encounters were examined for identifiable individuals. Ideally, photographs were taken with the dorsal fin and saddle patch fully visible, at a 90° angle from the whale, and were of good quality (good lighting conditions, focus, and image resolution). Photographs were adjusted to increase brightness and clarity in Adobe Lightroom when necessary, and cropped to frame only the dorsal fin and saddle patch for the catalogue. Adult killer whales were uniquely identified by nicks, scratches and scars, and pigmentation patterns on their dorsal fin and saddle patch (Figure 2; Bigg 1982). The shape and size of the dorsal fin, pigmentation pattern of the eye patch, and large scars visible on other parts of the body were also used for identification.

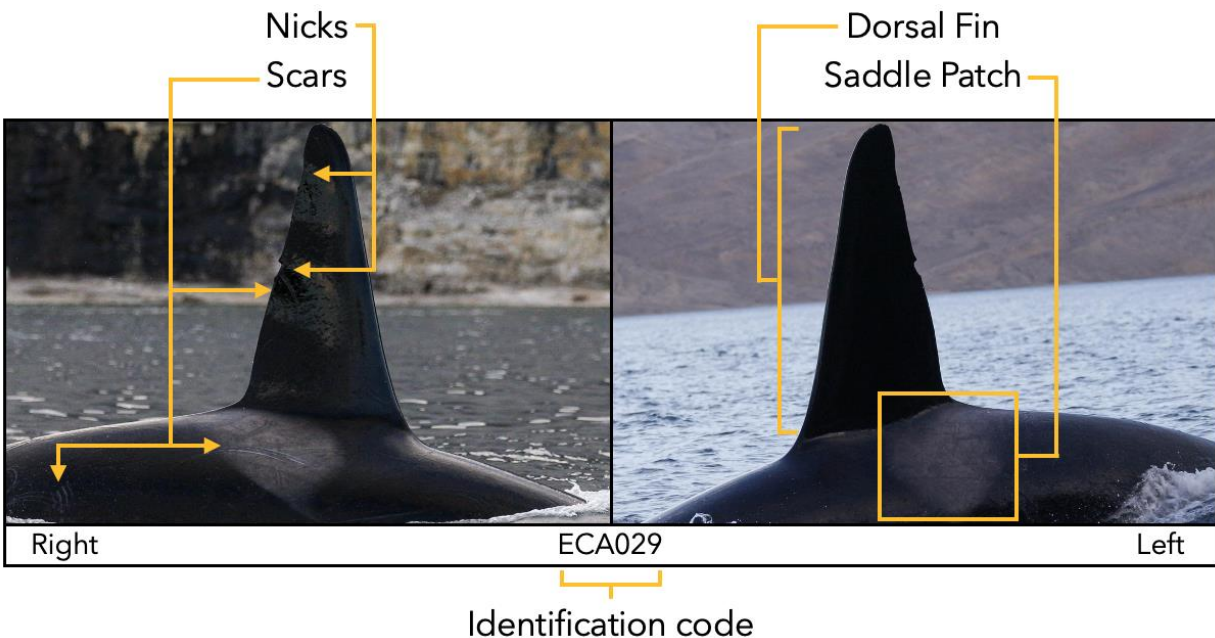
To ensure reliable identification of individuals, we first assigned quality scores to photo-identification images following the grading process developed by Durban et al. (2010). In this process, photographs were assessed for overall utility based on image size, focus, angle, and clarity. Images were assigned a score between 1 and 4 reflecting the useability of the saddle patch and dorsal fin for identification. A score of 4 indicates the fin and saddle patch are both displayed in useable quality; 3 indicates a useable fin only (i.e., saddle not visible); 2 indicates a useable saddle only (dorsal fin not framed in image); and 1 if neither the dorsal fin or saddle patch is useable (and thus excluded). Next, photographs with quality scores of 2-4 were evaluated for key features including notches in the dorsal fin, distinctive dorsal fin shape, distinctive saddle patch pigmentation patterns, black or white scratches in the saddle patch, and oval scars in the saddle patch. Individuals were included in the catalogue if they had at least one distinctive mark visible in a photo of useable quality, since these features can be retained for several decades (Towers et al. 2019, 2020). Photos of lesser quality, such as those not in focus, were only included if markings were sufficiently distinct that they would be easily recognized in a focused image. All photographs of new and known individuals are maintained in a DFO database using Lightroom Creative Cloud.

Photographs from the left and right sides of the same individual may be matched if a unique feature, such as a nick in the dorsal fin, is recognizable from both sides, or if

the photographer records which photographs were of the same individual. Although left-side photographs are more commonly used in killer whale photo-ID catalogues from other regions, we collected a greater number of right-side photos and thus used the right side for identification. Left-side photographs were matched to right-side photographs when possible. Left-side photographs that could not be matched are included in Appendix 1. We compared the individuals in this catalogue to photographs of individuals taken elsewhere in the North Atlantic. Finally, we estimated the number of adult male killer whales in the catalogue based on dorsal fin size and shape.

### 2.3 ID KEY

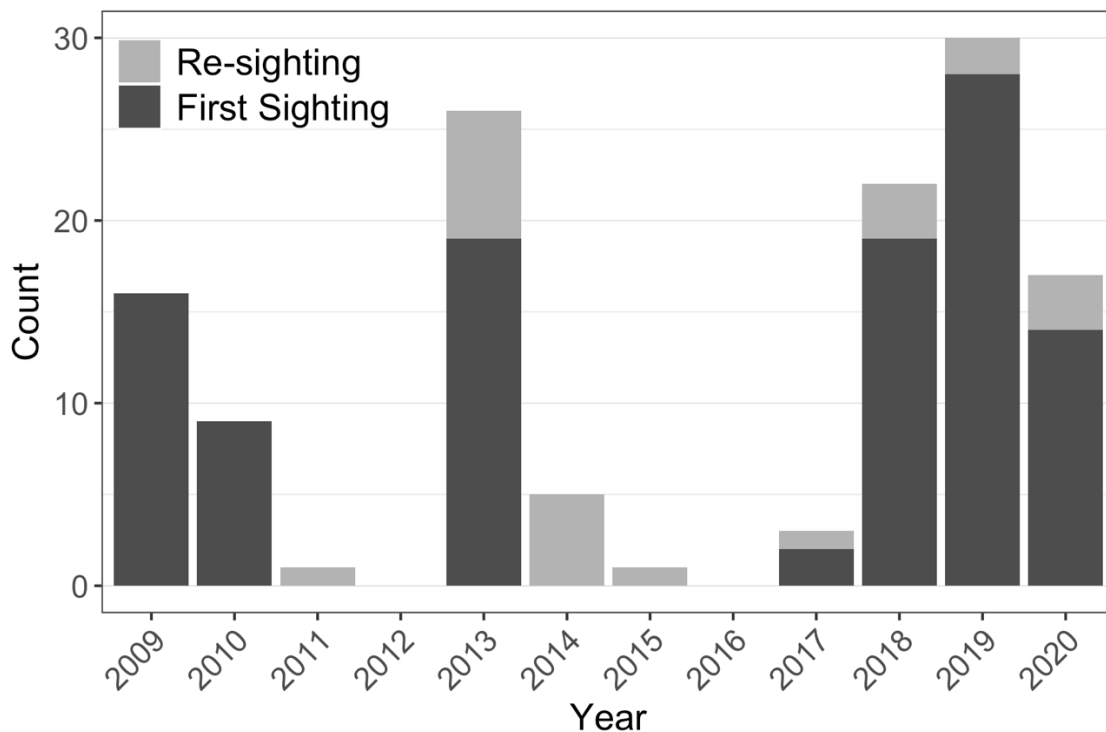
Good-quality photographs of individuals with distinguishable features were compared to the existing database. If a match was found, all good-quality photographs from the encounter were added to that individual's folder. If no match was found, the individual was assigned a unique identification code and added to the database. The identification codes include the prefix 'ECA', for 'Eastern Canadian Arctic', and the order in which the individual was identified (e.g., ECA001). The code is not representative of the age of the individual, the chronological order in which they were sighted, or social groupings. This document contains the most recent or the best-quality right-side (and left-side, if available) photograph of all identified individuals recorded in the Tallurutiup Imanga NMCA and surrounding waters between 2009 and 2020, and Cumberland Sound in 2011 and 2020 (Section 4). Calves were not included. Although only one photo per whale is included in this document, additional catalogue photos of individuals identified in Section 4 from the same or subsequent encounters (re-sightings) are saved in the DFO Lightroom database. The individual sighting information contains the history of all documented sightings of a known individual (Section 5).



**Figure 2.** Examples of nicks, scars, and rake marks on the dorsal fin and saddle patch that may be used to identify individual killer whales.

### 3. RESULTS AND DISCUSSION

We identified 94 individual killer whales between 2009 and 2020 in the Tallurutiup Imanga NMCA and surrounding area (Figure 3). Based on dorsal fin size, we classified 18 as adult males and 76 as females or sub-adult males. Of the latter group, we noted that 3-5 individuals may have been “sprouting” at the time of the encounter; a period during which males experience rapid growth of the dorsal fin prior to reaching maturity (Olesiuk et al. 2005). We also identified eight killer whales in Cumberland Sound in 2011 and 2020; three adult males and five females or sub-adult males. Thirteen of the whales we identified were re-sighted around northern Baffin Island during the 12-year period (Figure 3). Two individuals were re-sighted four times, two individuals were re-sighted three times, and nine individuals were re-sighted once for a total of 23 re-sightings.



**Figure 3.** Number of newly identified individuals and number of individuals re-sighted from photographs each year in the Tallurutiup Imanga NMCA and surrounding area from 2009-2020.

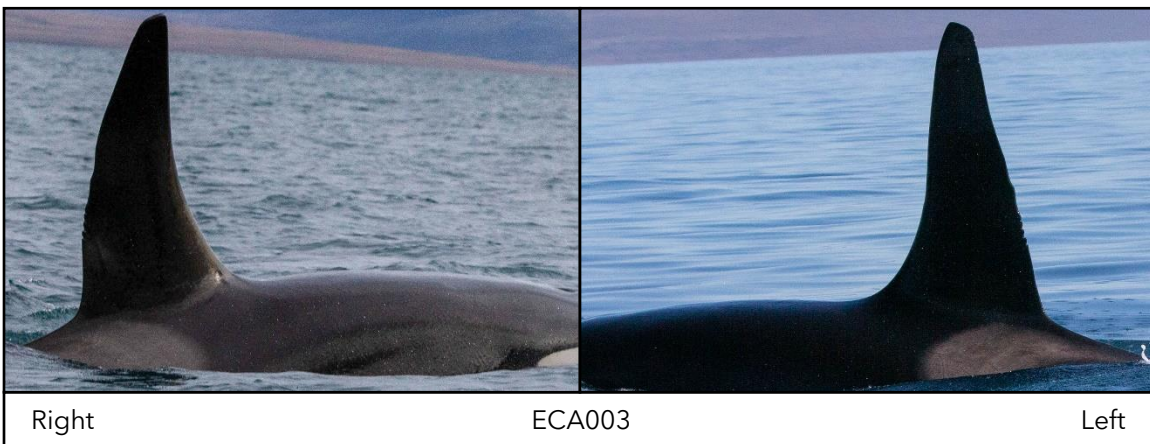
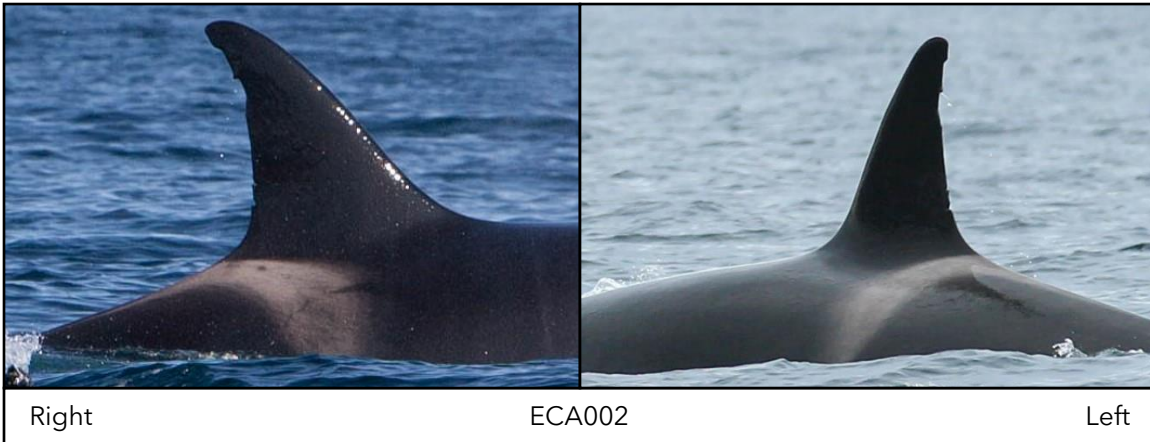
While none of the Cumberland Sound individuals were re-sighted in Cumberland Sound, one individual (ECA056), first photographed in Eclipse Sound in 2018, was re-sighted in Cumberland Sound in 2020. Similarly, another individual (ECA057), first

photographed in Eclipse Sound in 2018, was re-sighted in Cumberland Sound in 2021. However, sightings from 2021 were not included in this document. It is possible that groups of killer whales travel along the eastern coast of Baffin Island, including into Cumberland Sound, as they move north in the summer or south in the fall, resulting in re-sightings between locations. However, the migration path may differ among years, or depend on the origin, timing, or individuals comprising a given group of killer whales. Further re-sightings of individuals in multiple locations or among catalogues of killer whales may help to reveal the movement patterns of these whales, which currently remain unclear. One satellite tagged individual tagged in Admiralty Inlet traveled to an area near the Azores, Portugal (Lat. 37.728°, Long. 40.701°) before transmissions ended (Matthews et al. 2011). Therefore, we compared individuals recorded in this catalogue to individuals photographed near the Azores islands (A. Laydevant, personal communication, 2023; G. Cabayol, personal communication, 2023), as well as Newfoundland (A. Erven, personal communication, 2023) and Greenland (Nielsen 2011, F. Ugarte, personal communication, 2022). Thus far, no individuals have been matched among catalogues.



## 4. CATALOGUE

### 4.1 TALLURUTIUP IMANGA NMCA AND SURROUNDING AREA





Right

ECA004

Left



Right

ECA005

Left



Right

ECA006

Left





Right

ECA007

Left



Right

ECA008

Left



Right

ECA009

Left



Right

ECA010

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Right

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ECA014

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ECA015

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Right

ECA016

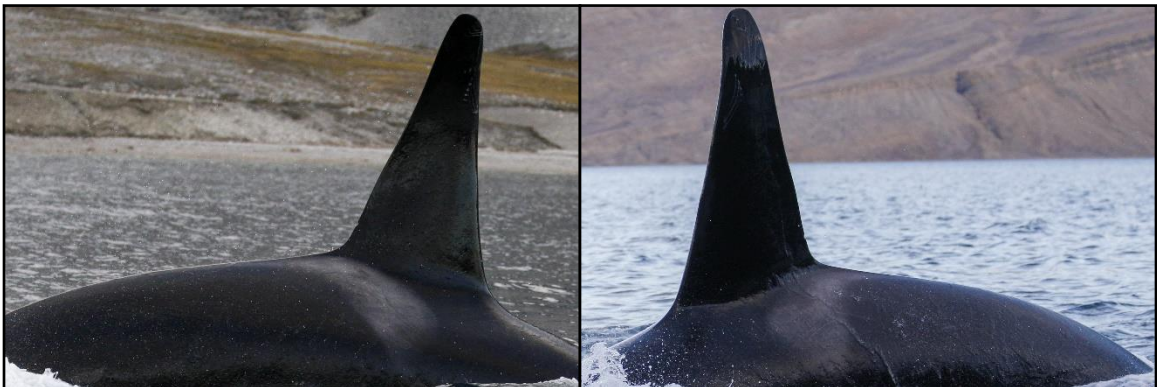
Left



Right

ECA017

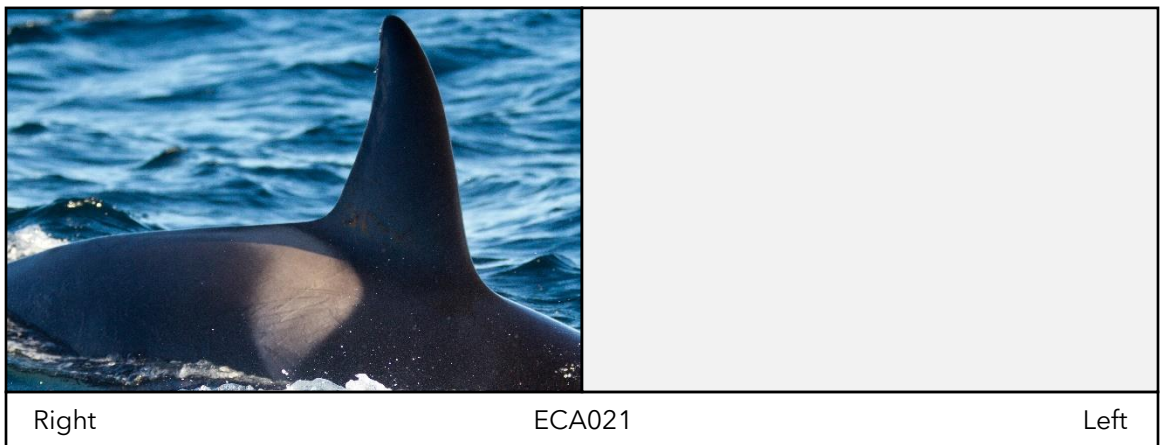
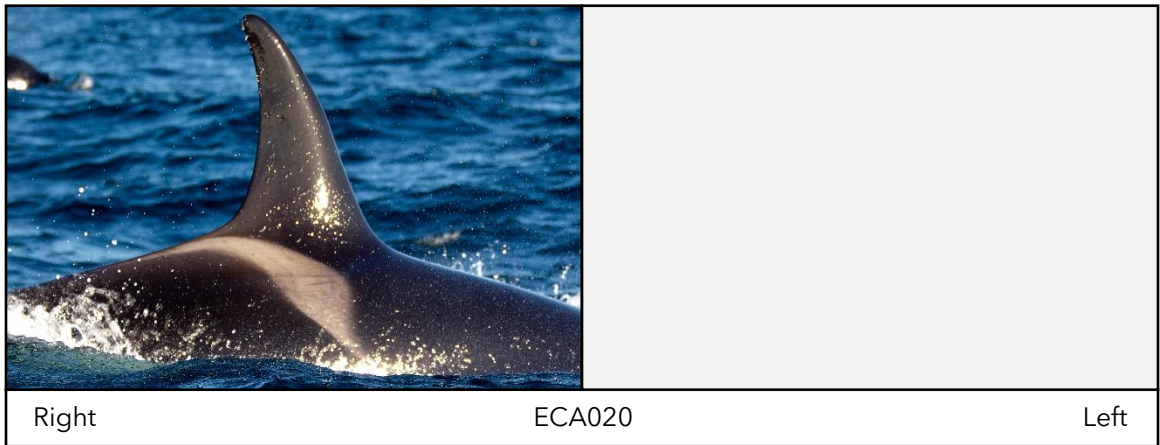
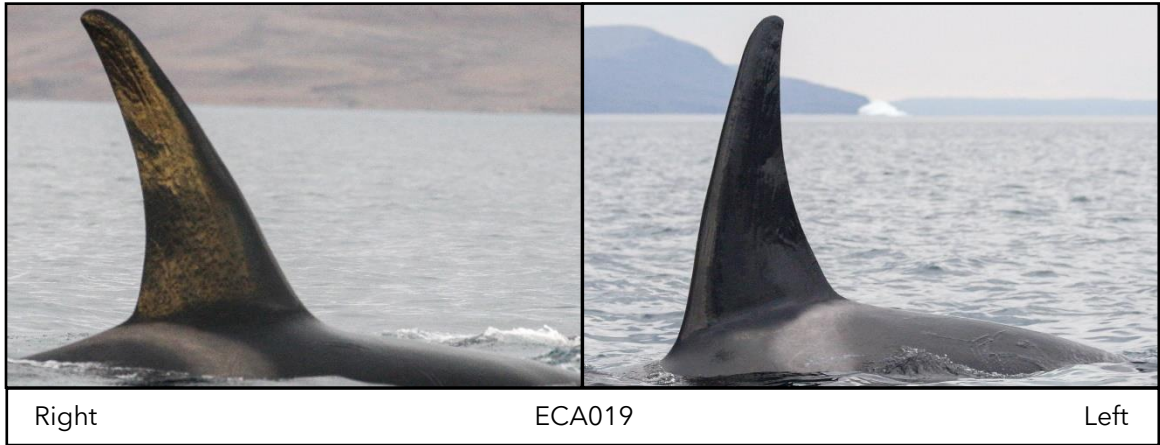
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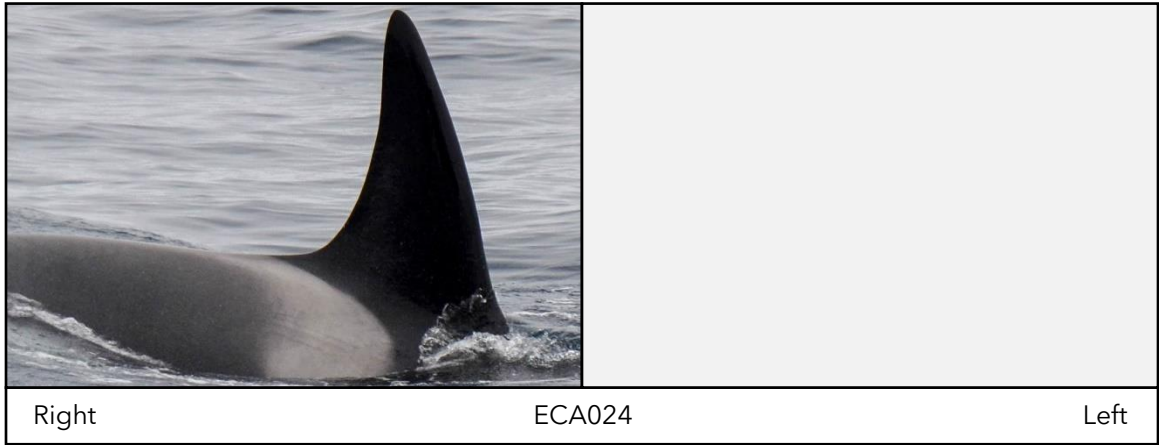
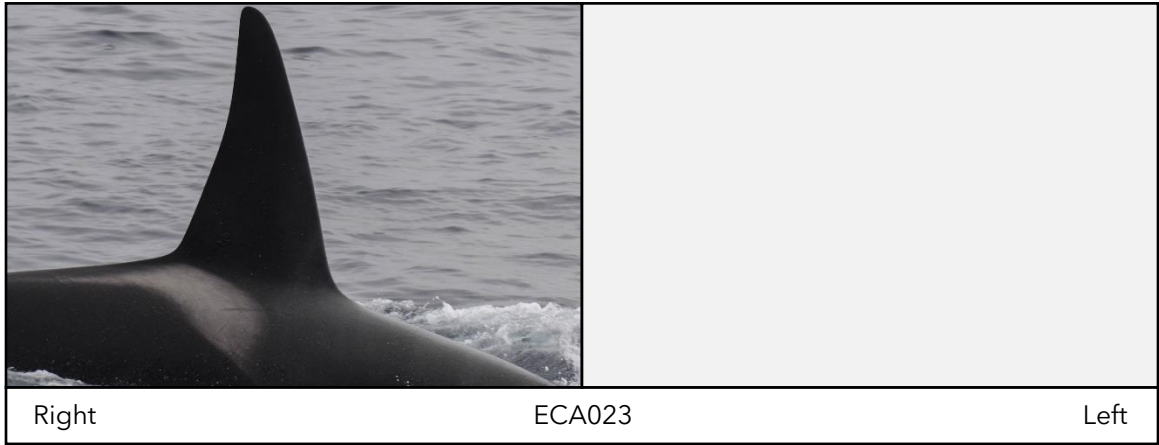
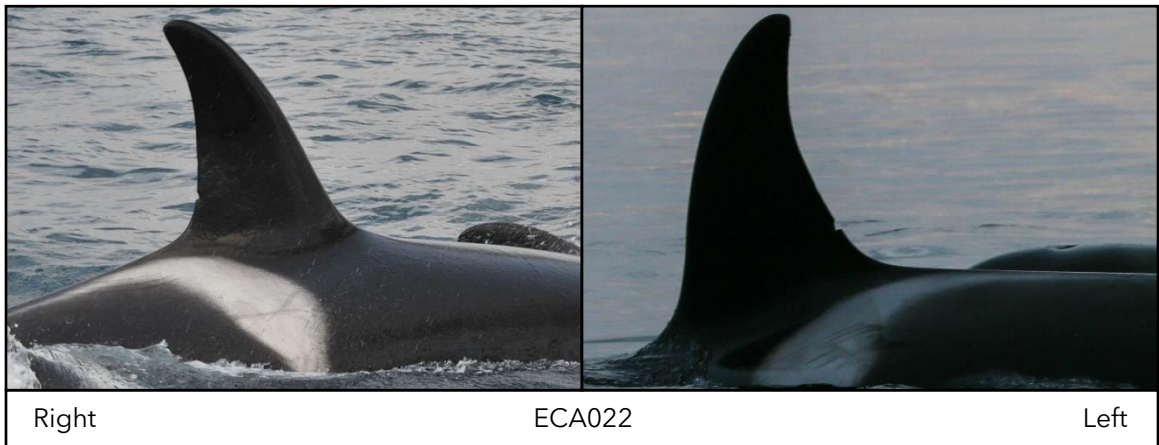


Right

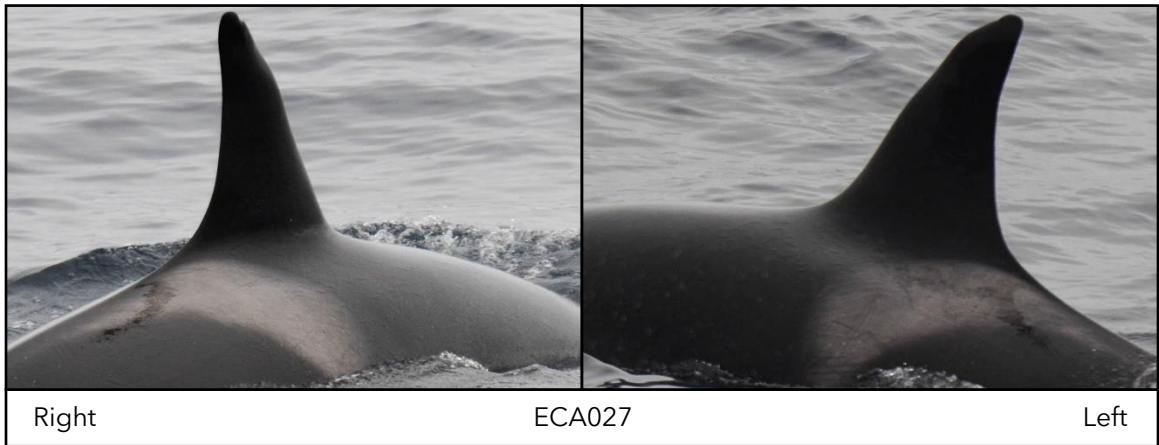
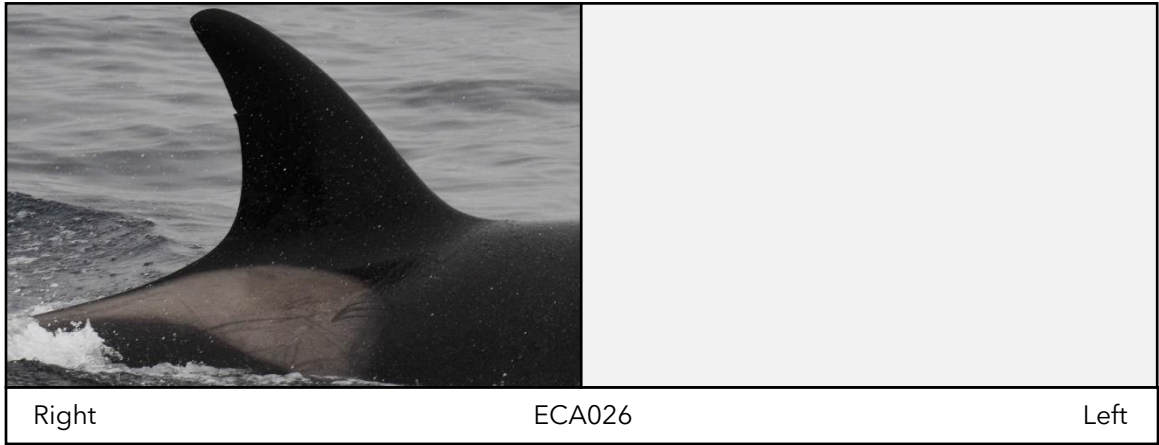
ECA018

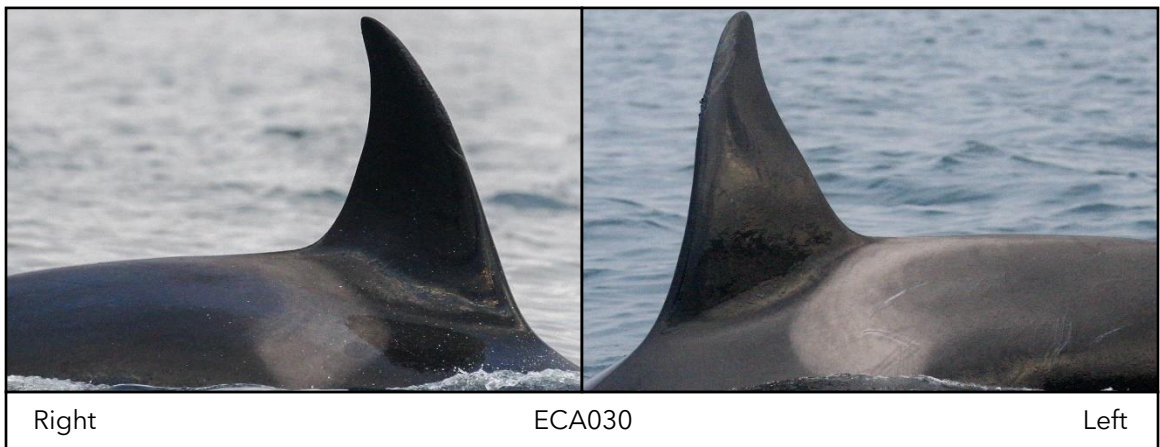
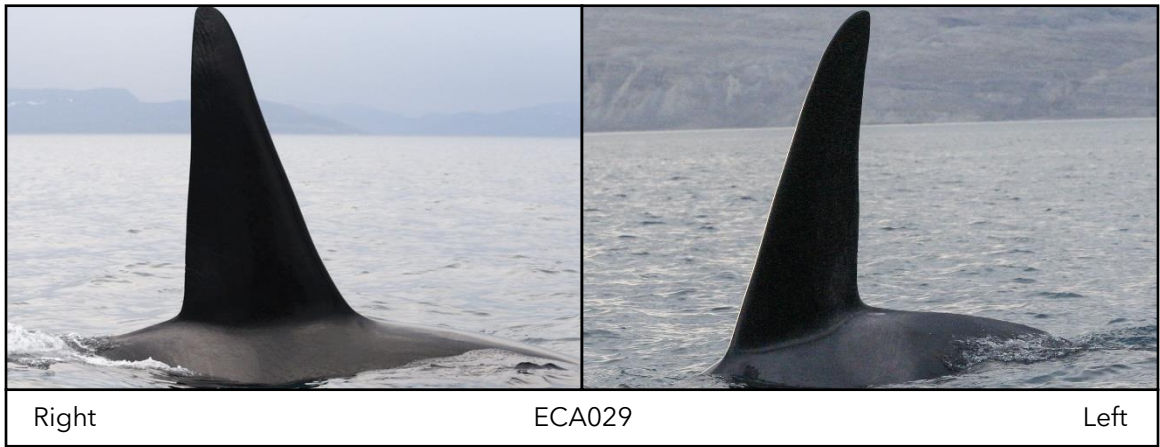
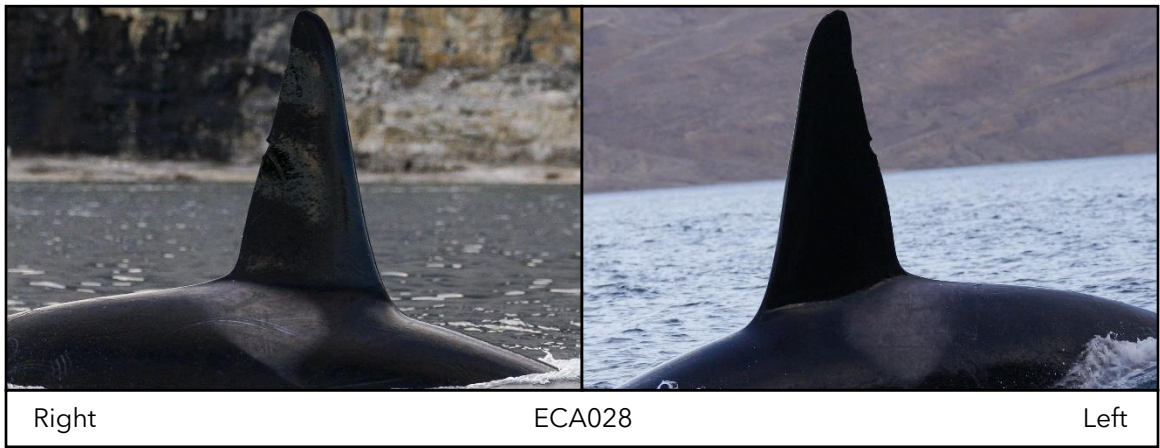
Left



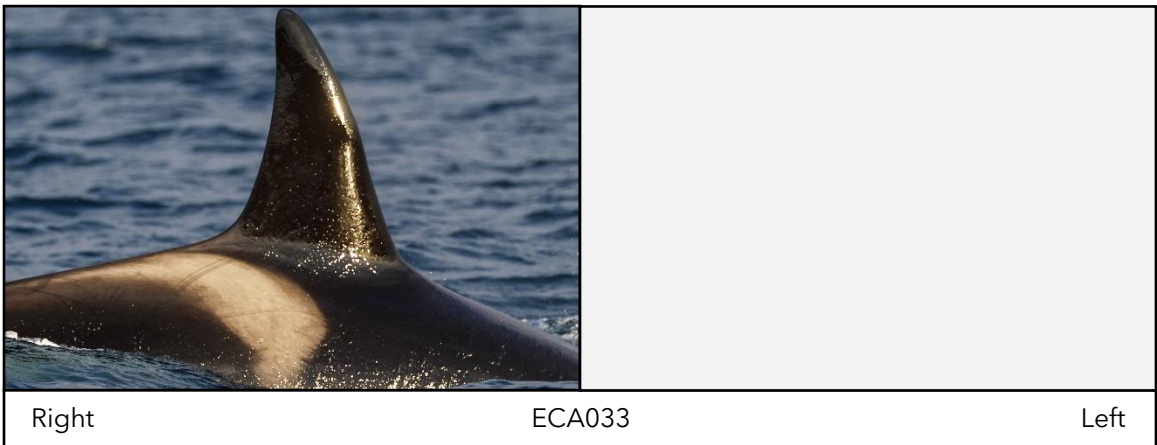
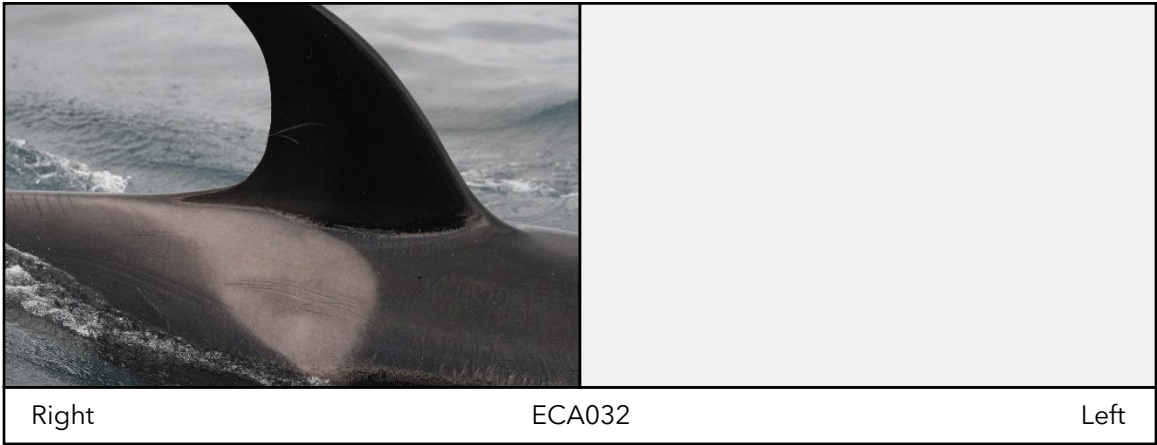
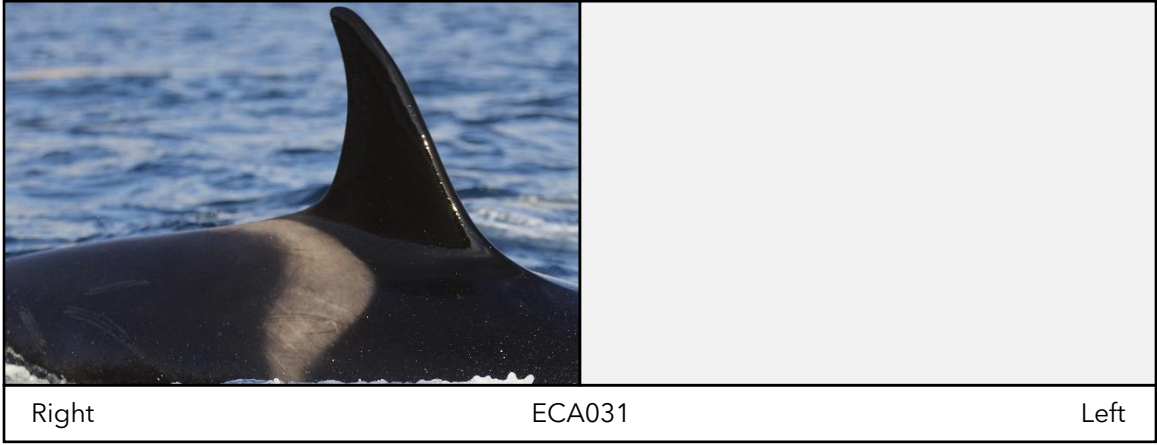


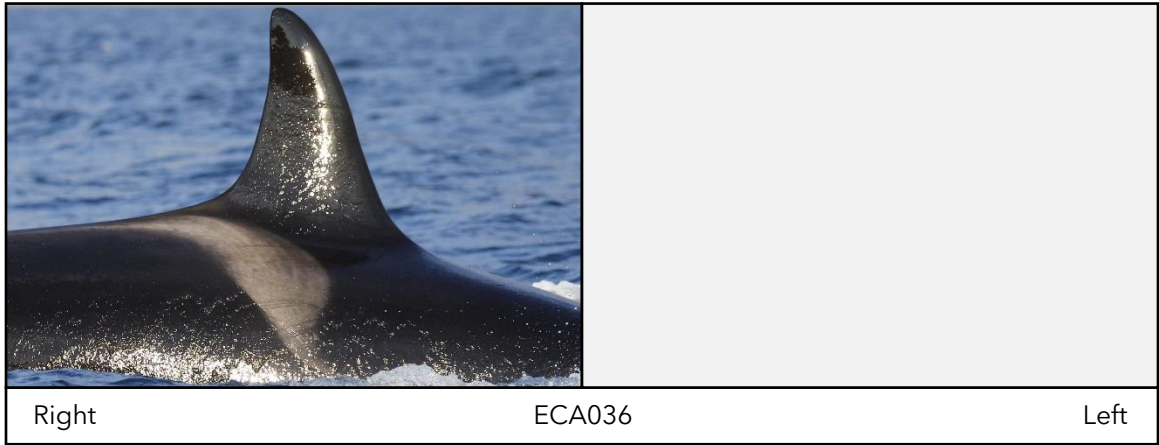
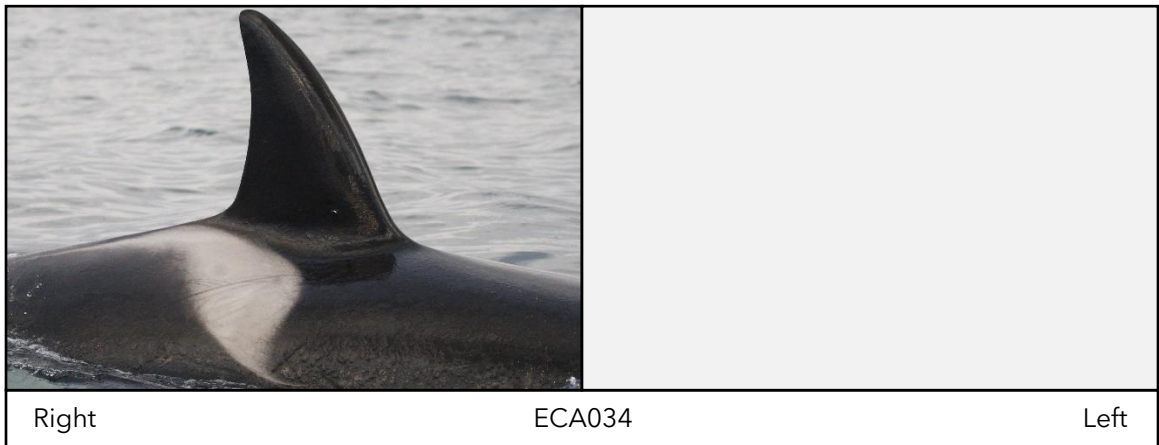


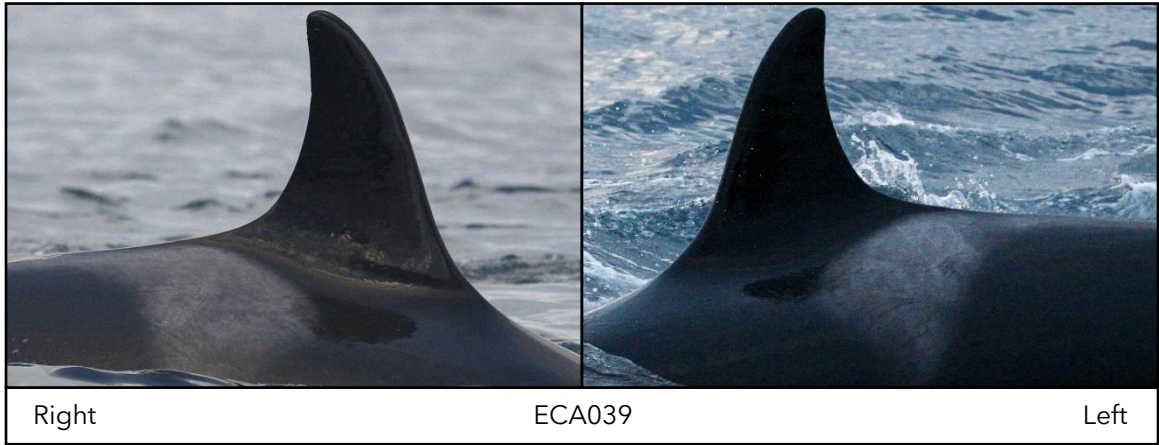
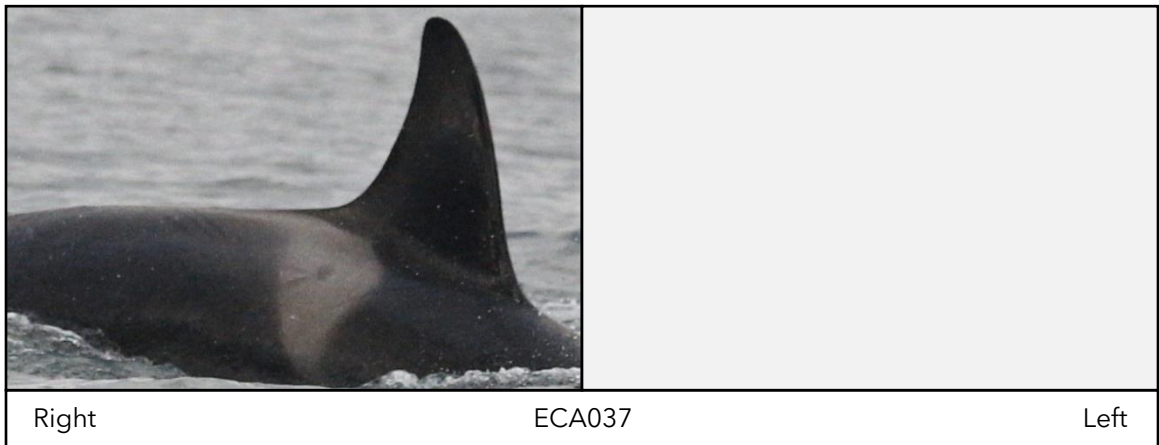


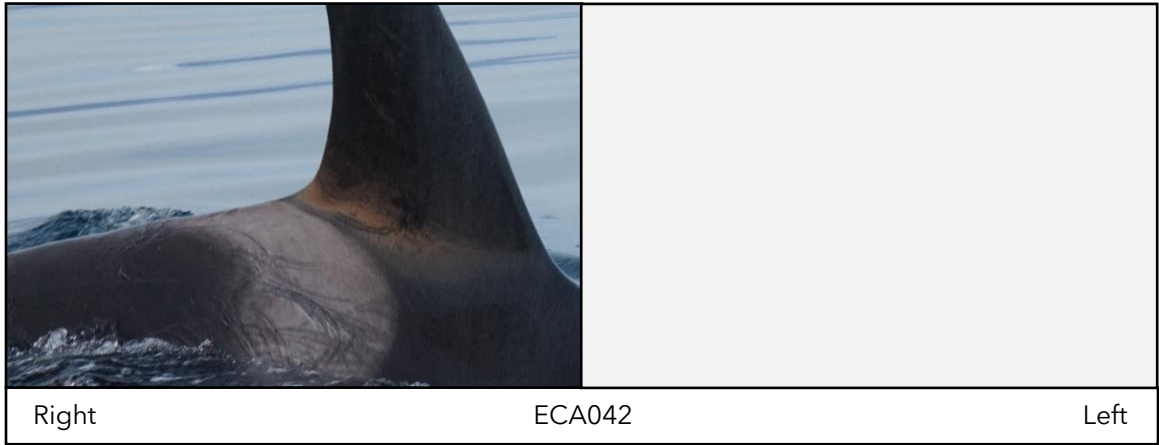
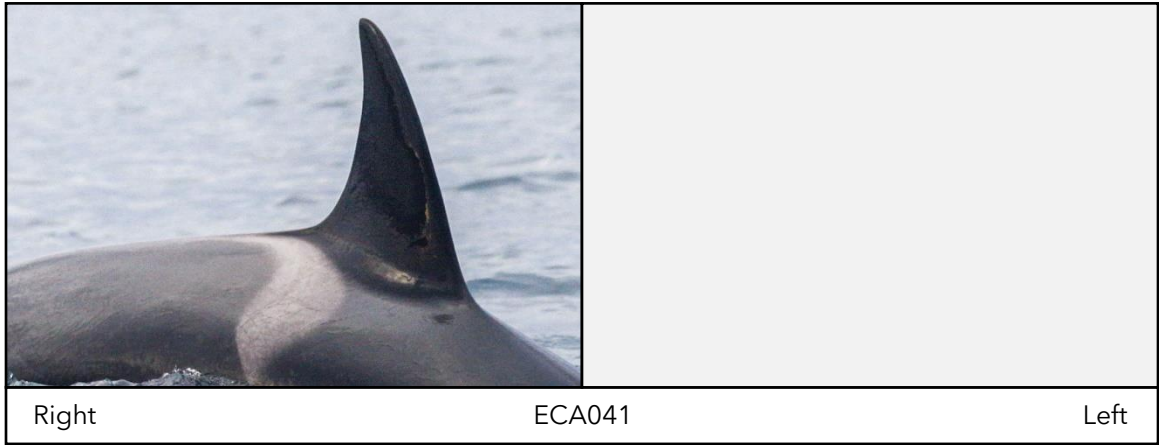
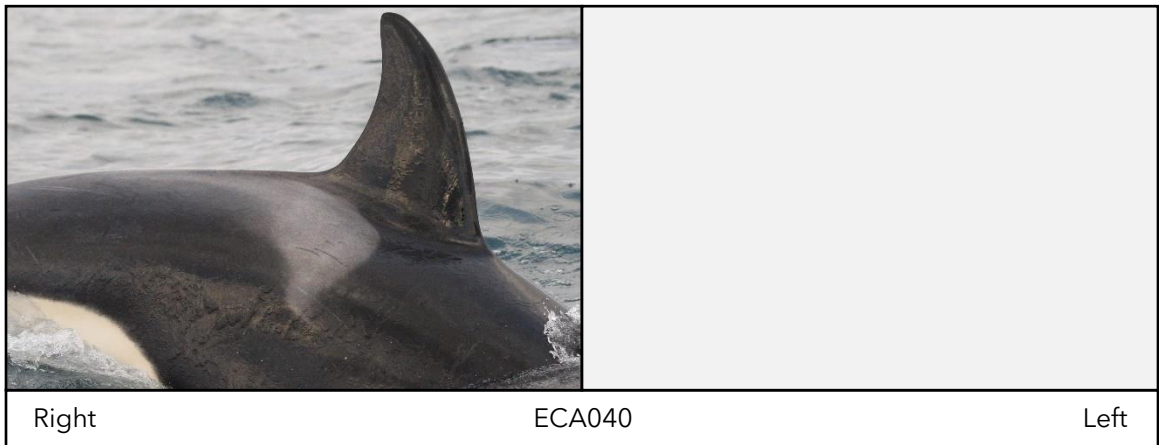
















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ECA043

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ECA044

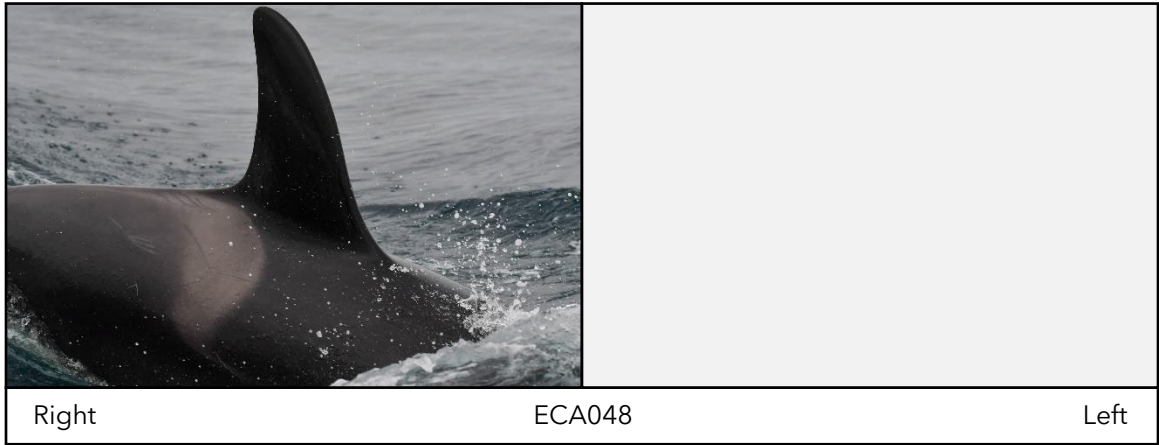
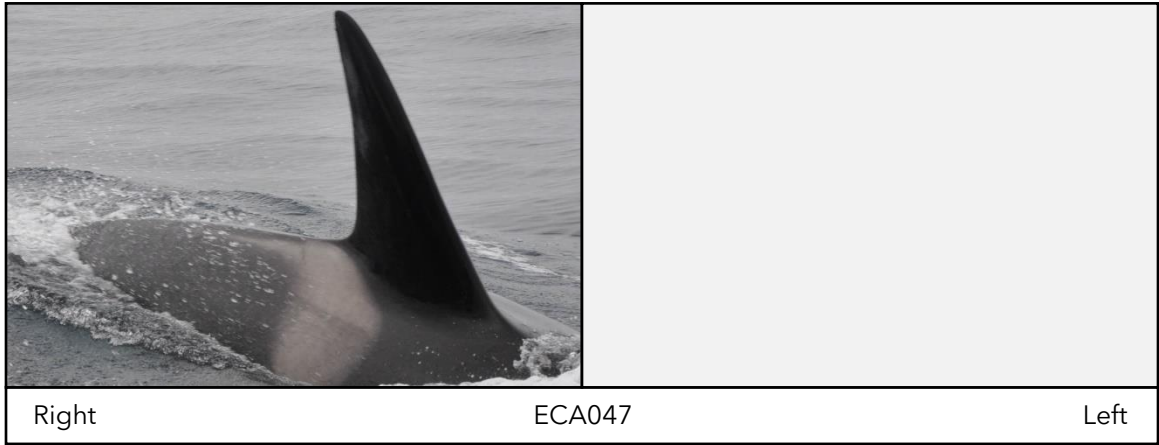
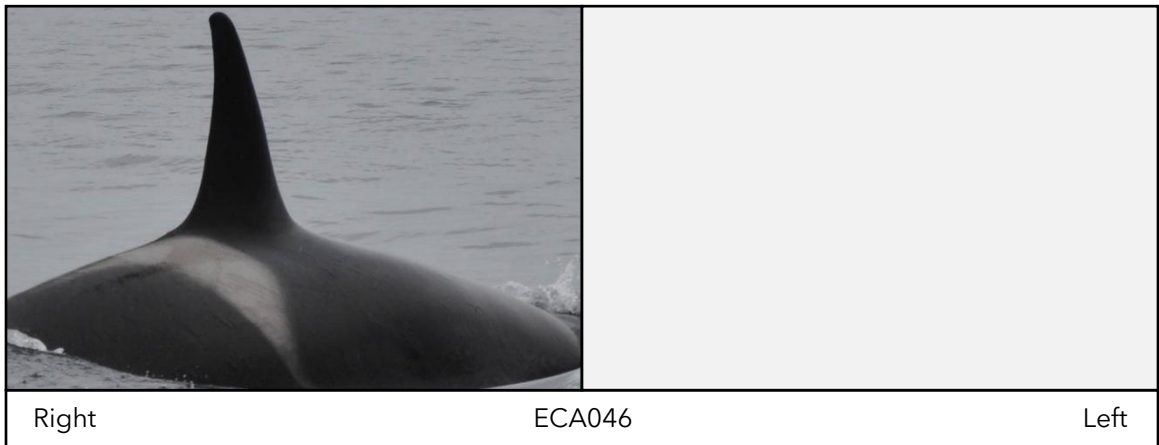
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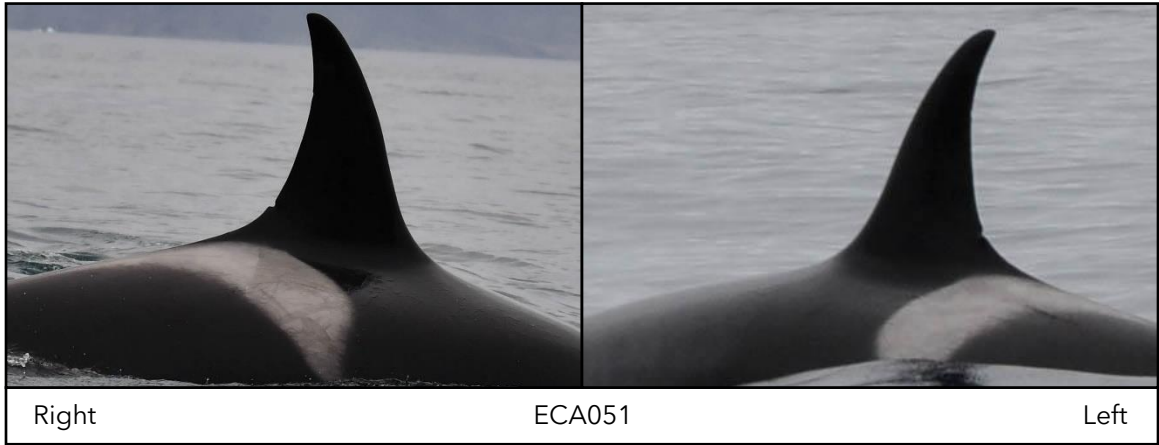
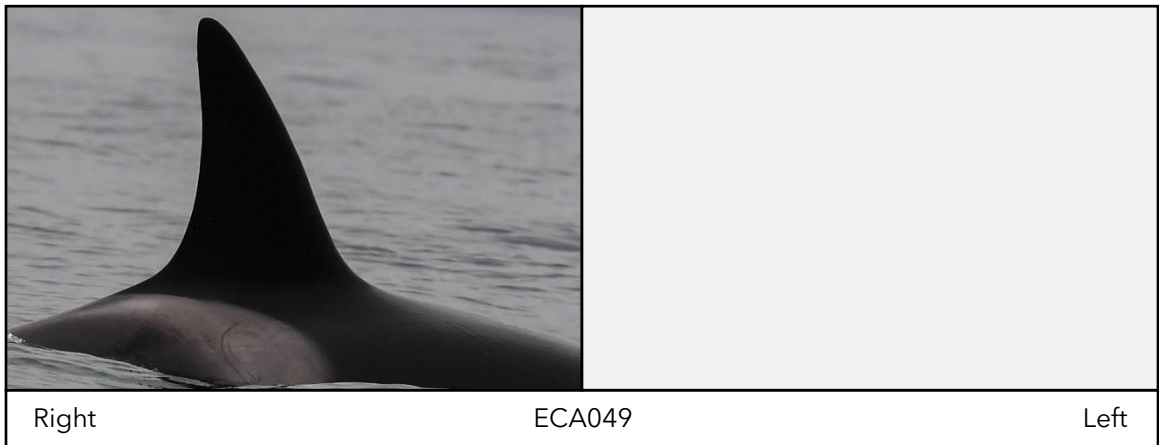


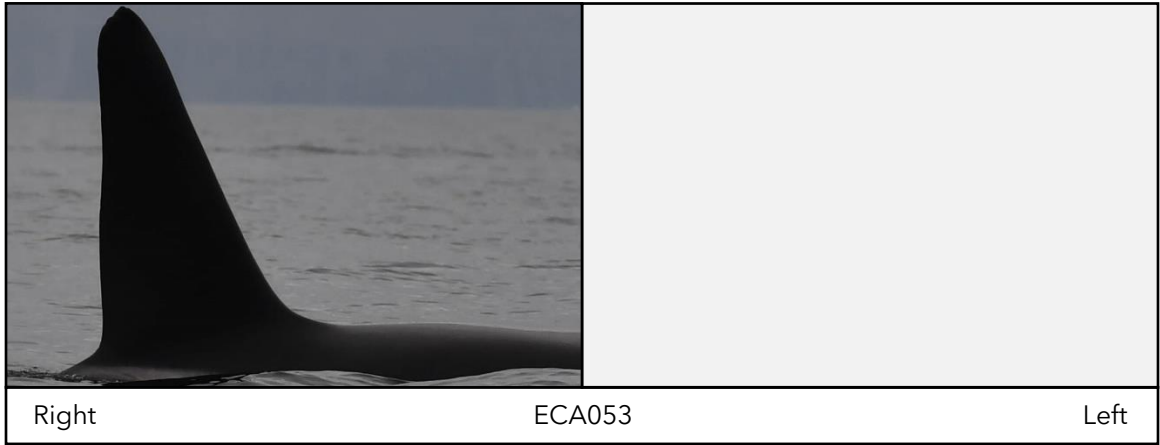
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ECA045

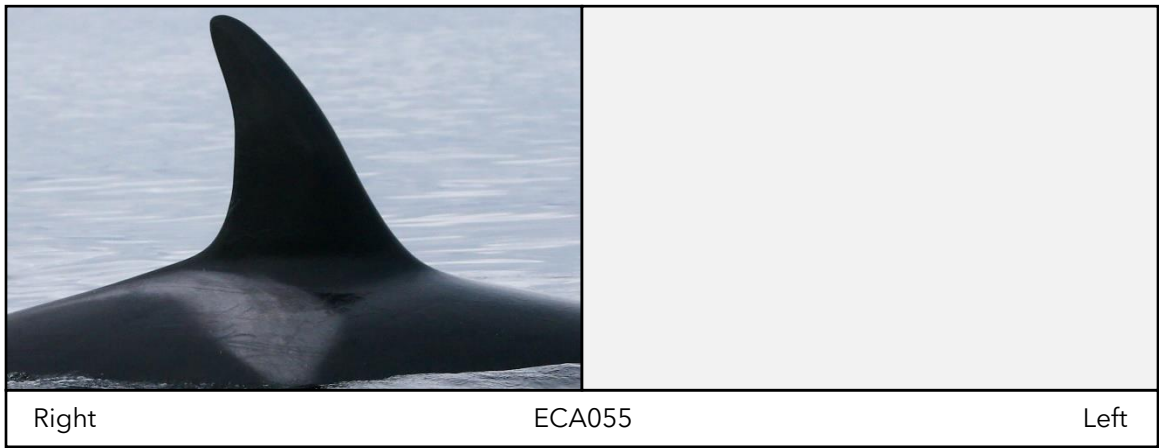
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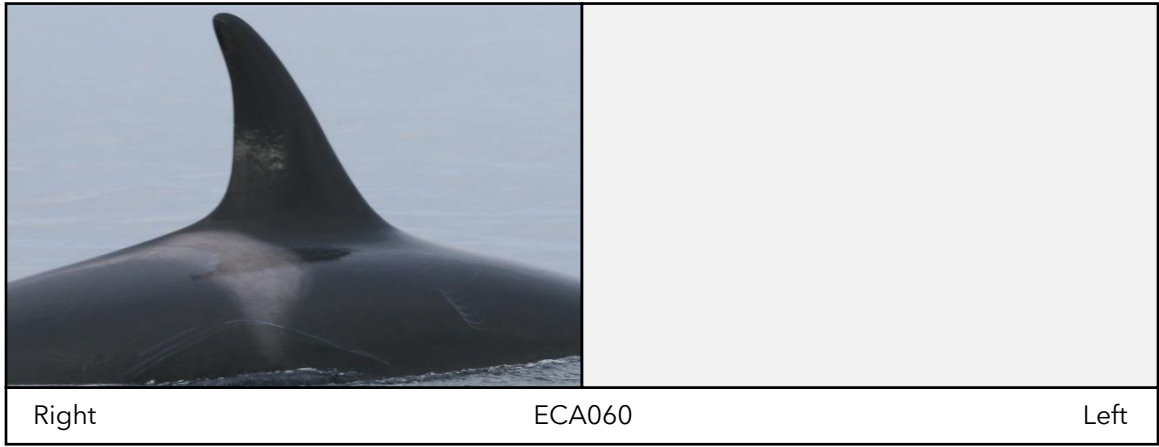
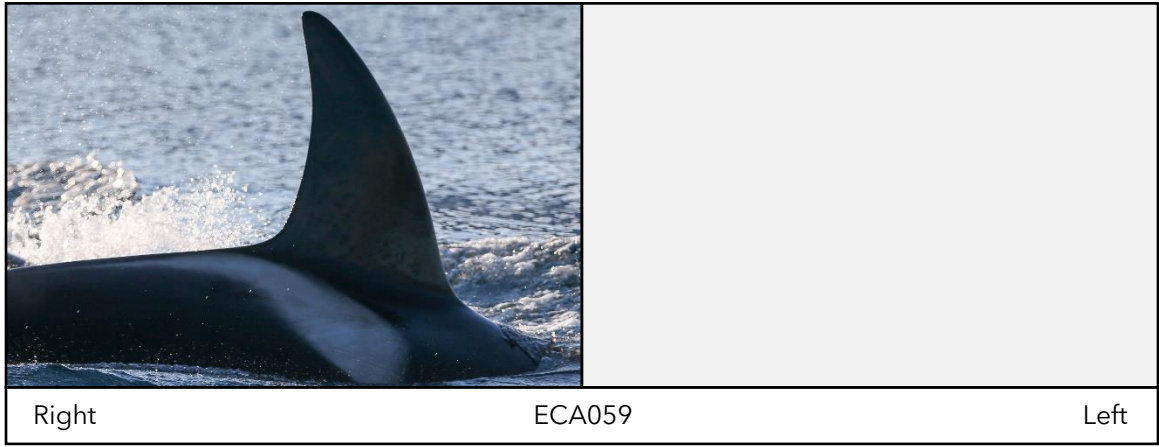


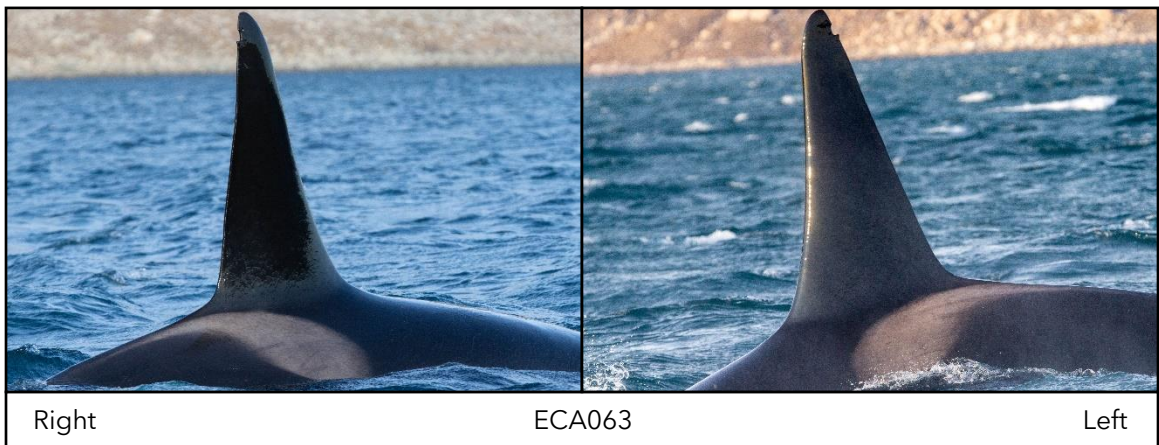
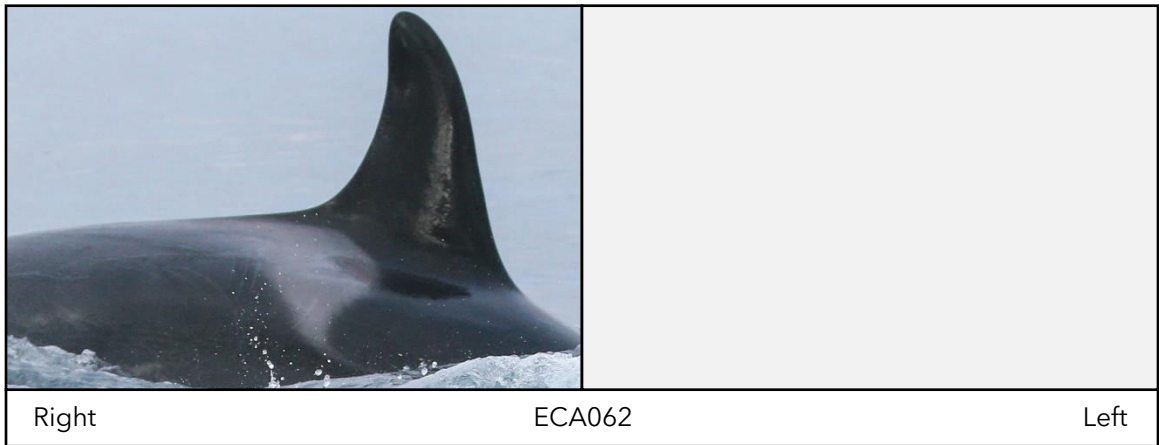
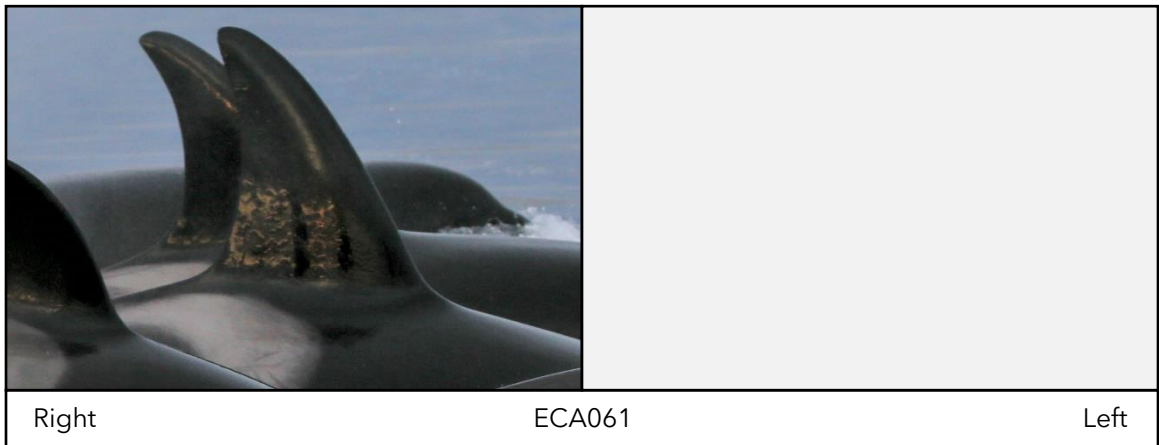














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ECA064

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ECA065

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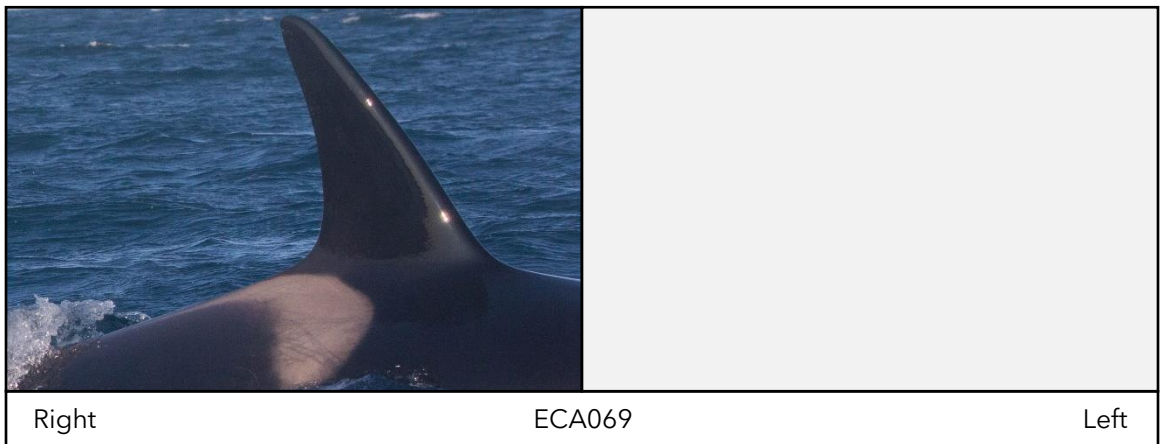


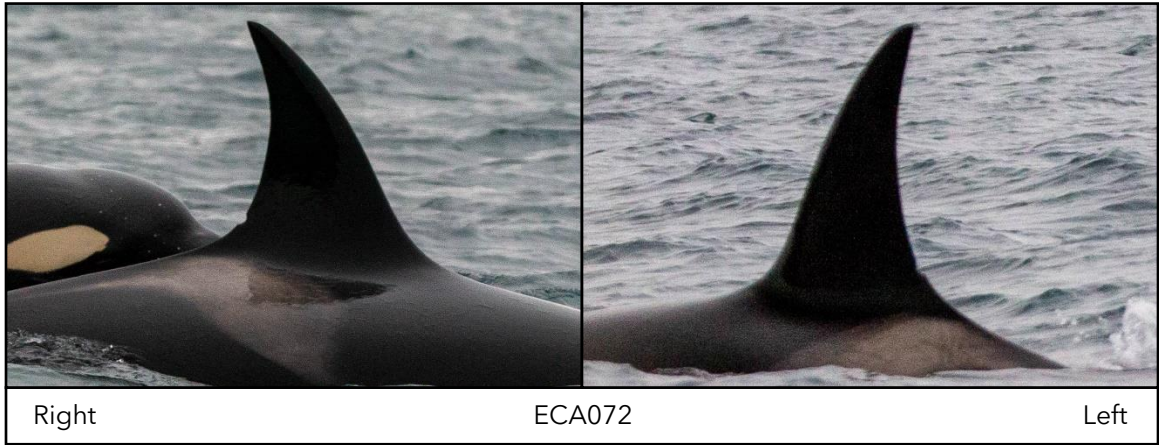
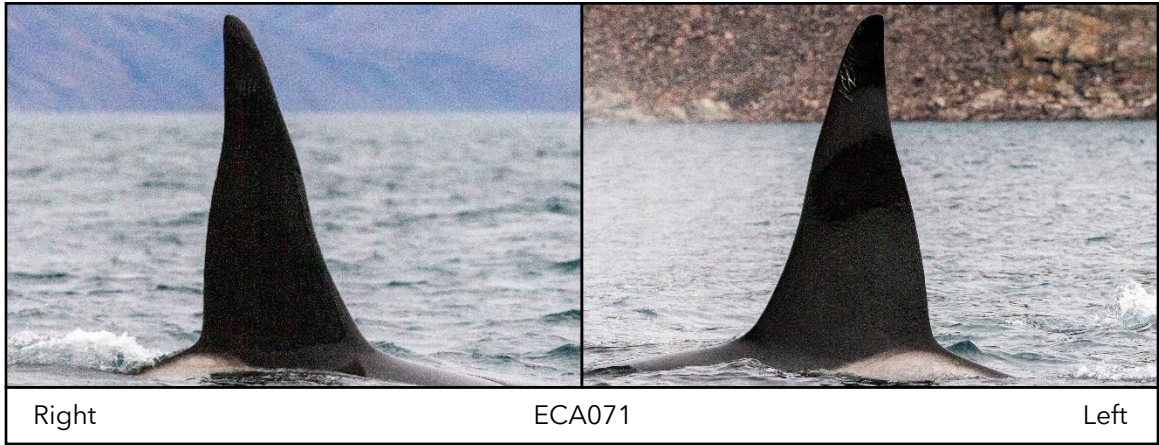
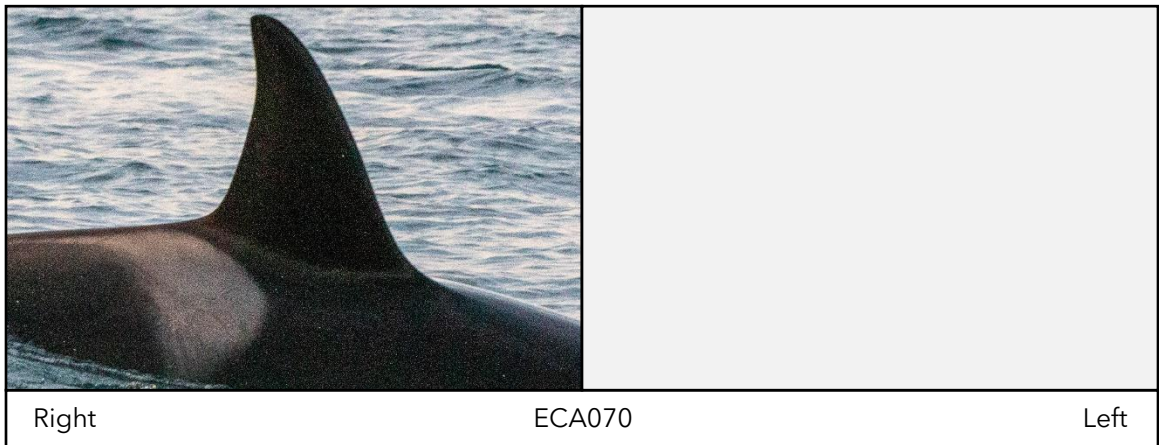
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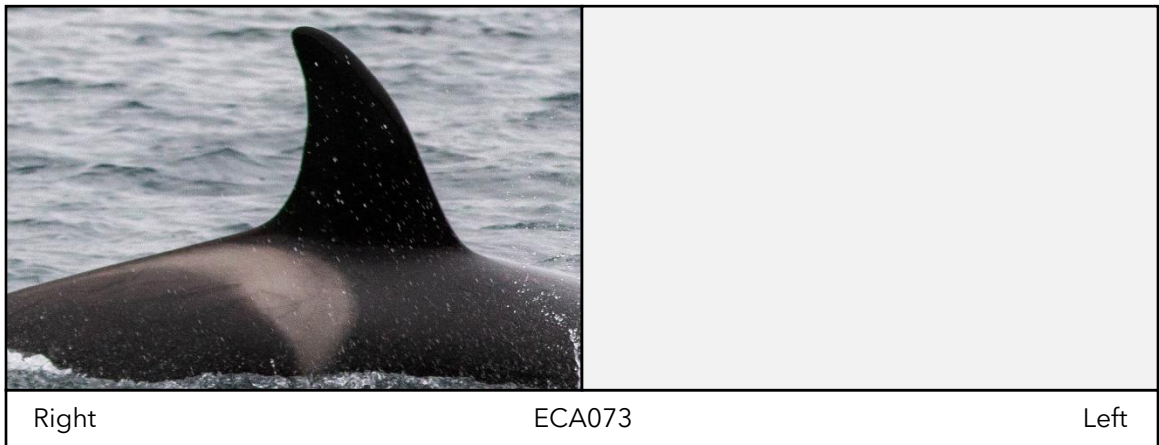
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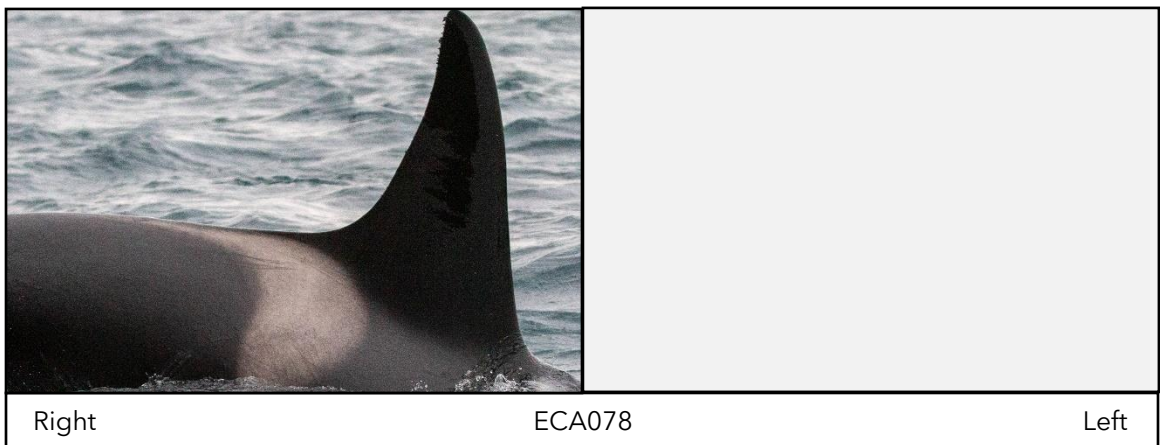
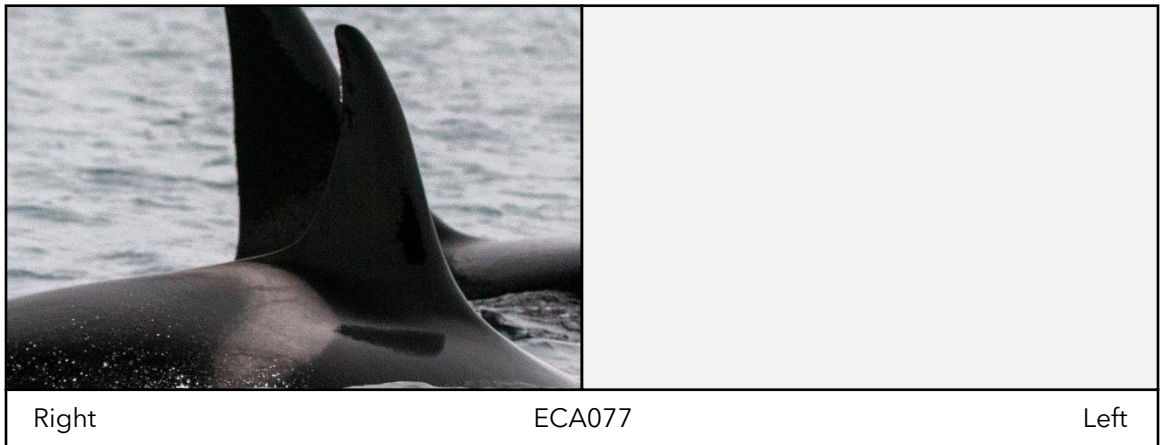
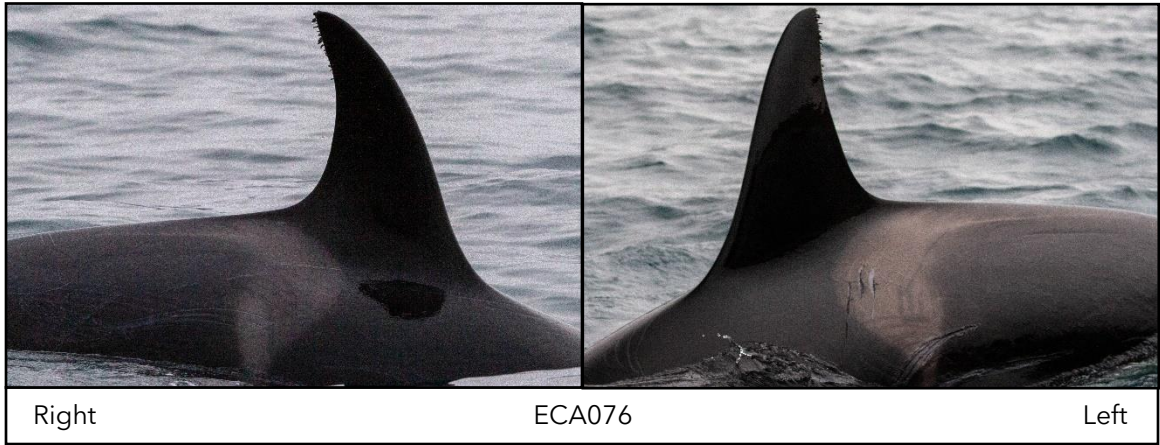




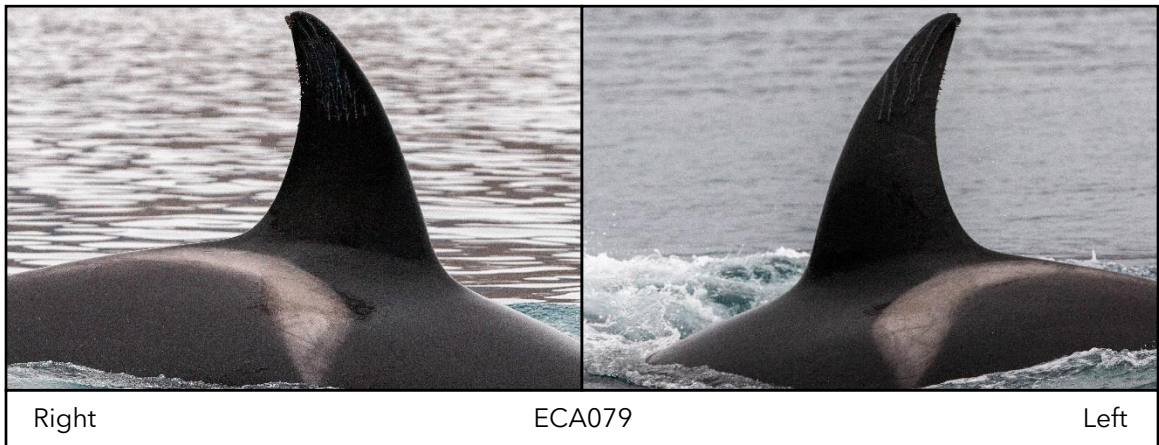














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ECA082

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ECA083

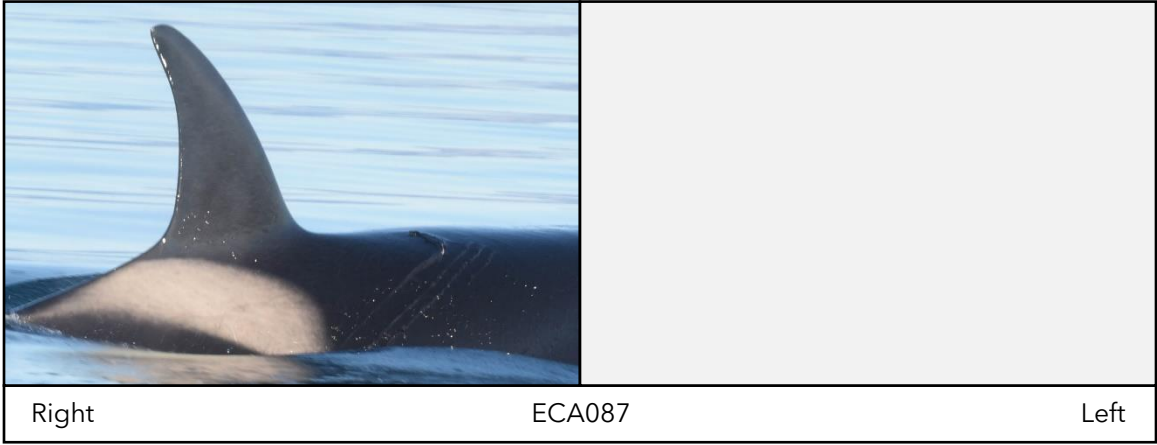
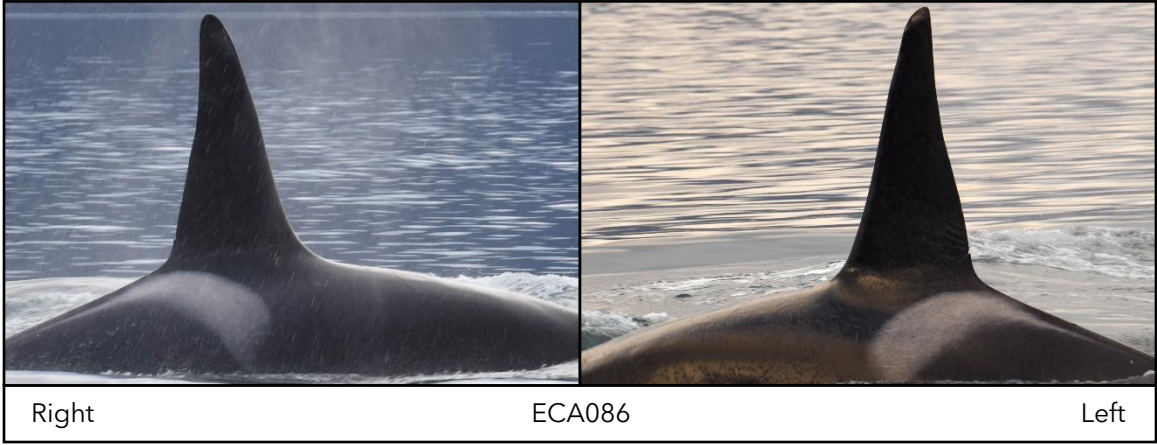
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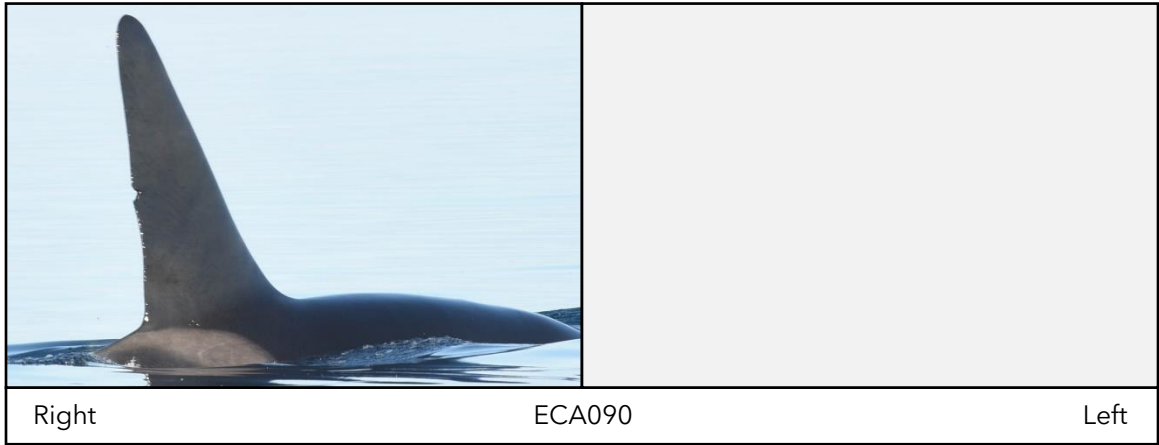
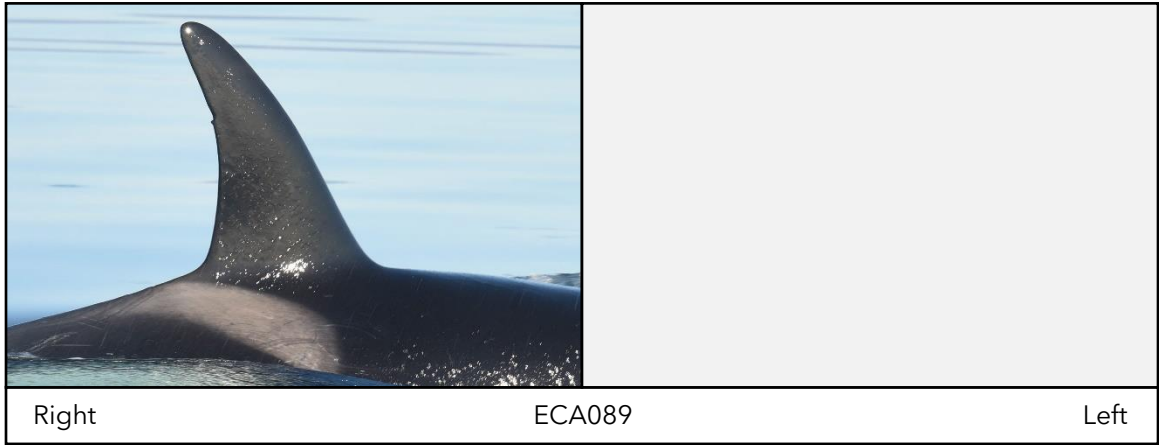
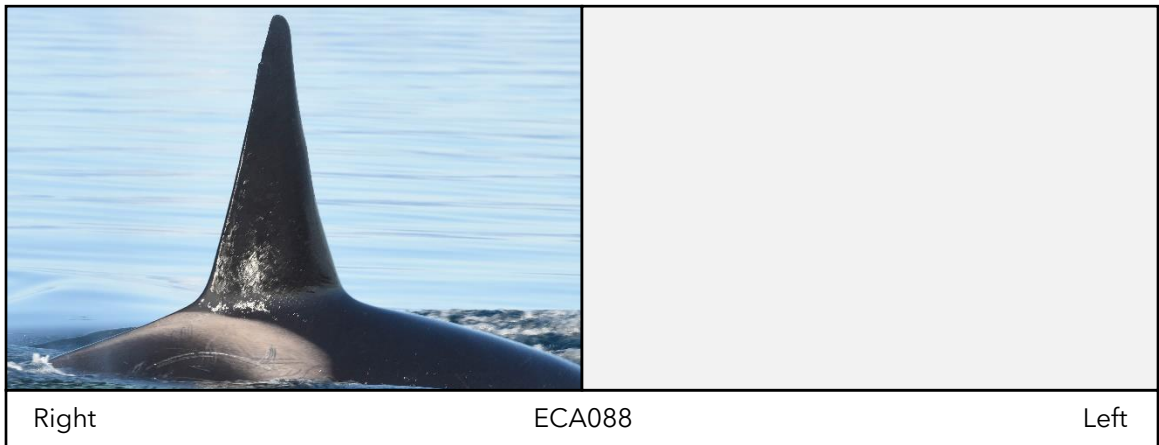


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ECA084

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ECA091

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ECA092

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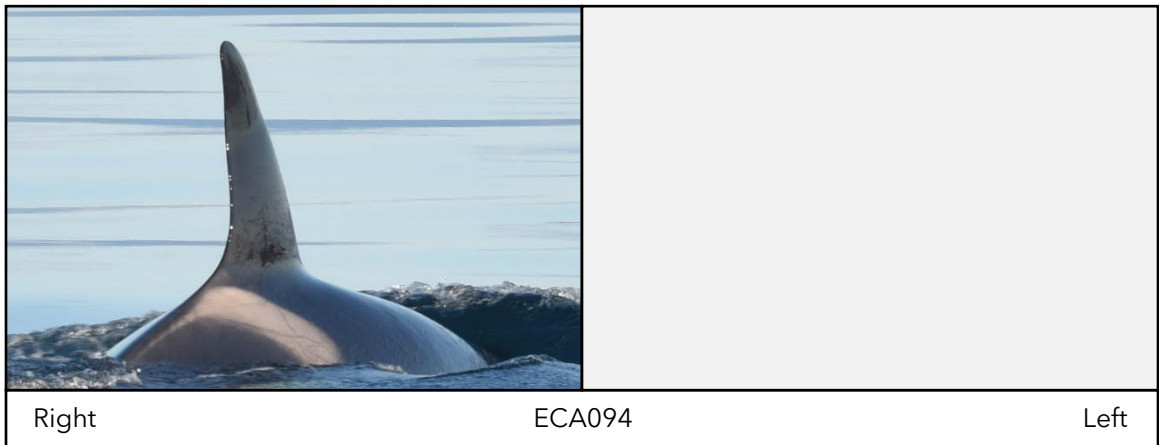


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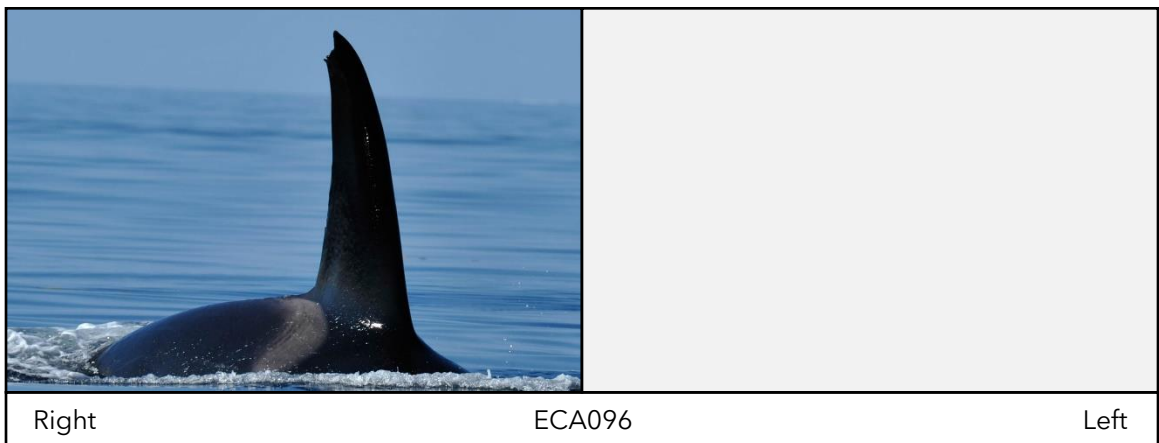
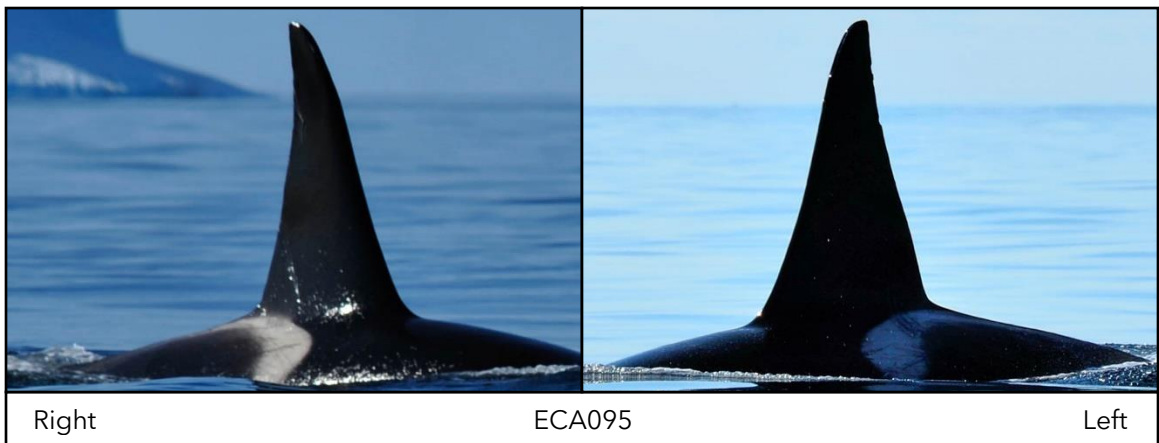
ECA093

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#### 4.2 CUMBERLAND SOUND





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ECA097

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ECA098

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ECA099

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ECA100

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ECA101

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ECA102

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## 5. INDIVIDUAL SIGHTING INFORMATION

### 5.1 TALLURUTIUP IMANGA AND SURROUNDING AREA

| Individual | Year | Location                | Photographer                |
|------------|------|-------------------------|-----------------------------|
| ECA001     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
|            | 2013 | Prince Regent Inlet, NU | Paul Prior                  |
|            | 2017 | Tremblay Sound, NU      | Max Bakken                  |
|            | 2018 | Eclipse Sound, NU       | Kyle Lefort                 |
|            | 2020 | Eclipse Sound, NU       | Enookie Inuarak             |
| ECA002     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
|            | 2013 | Prince Regent Inlet, NU | Paul Prior                  |
|            | 2015 | Admiralty Inlet, NU     | Gretchen Freund             |
|            | 2018 | Eclipse Sound, NU       | Kyle Lefort                 |
|            | 2020 | Eclipse Sound, NU       | Enookie Inuarak             |
| ECA003     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
|            | 2019 | Eclipse Sound, NU       | Maha Ghazal                 |
| ECA004     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA005     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA006     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA007     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA008     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA009     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA010     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA011     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA012     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA013     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA014     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA015     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA016     | 2009 | Admiralty Inlet, NU     | Gretchen Freund             |
| ECA017     | 2010 | Admiralty Inlet, NU     | Gretchen Freund             |
|            | 2013 | Milne Inlet, NU         | JM Hillier, Gretchen Freund |
| ECA018     | 2010 | Admiralty Inlet, NU     | Gretchen Freund             |
|            | 2013 | Milne Inlet, NU         | JM Hillier, Gretchen Freund |

| Individual | Year | Location             | Photographer                |
|------------|------|----------------------|-----------------------------|
| ECA019     | 2010 | Admiralty Inlet, NU  | Gretchen Freund             |
|            | 2011 | Navy Board Inlet, NU | Jess Taunton, Chris Bray    |
|            | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
|            | 2014 | Admiralty Inlet, NU  | Gretchen Freund             |
| ECA020     | 2010 | Admiralty Inlet, NU  | Gretchen Freund             |
|            | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA021     | 2010 | Admiralty Inlet, NU  | Gretchen Freund             |
| ECA022     | 2010 | Admiralty Inlet, NU  | Gretchen Freund             |
|            | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
|            | 2014 | Eclipse Sound, NU    | Nate Small                  |
|            | 2018 | Eclipse Sound, NU    | Maha Ghazal                 |
| ECA023     | 2013 | Lancaster Sound, NU  | Jack Putman                 |
| ECA024     | 2013 | Lancaster Sound, NU  | Jack Putman                 |
| ECA025     | 2013 | Lancaster Sound, NU  | Jack Putman                 |
|            | 2017 | Tremblay Sound, NU   | Max Bakken                  |
| ECA026     | 2013 | Lancaster Sound, NU  | Jack Putman                 |
| ECA027     | 2013 | Lancaster Sound, NU  | Jack Putman                 |
| ECA028     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
|            | 2014 | Admiralty Inlet, NU  | Gretchen Freund             |
| ECA029     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA030     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA031     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA032     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA033     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA034     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
|            | 2014 | Eclipse Sound, NU    | Nate Small                  |
| ECA035     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
|            | 2014 | Eclipse Sound, NU    | Nate Small                  |
| ECA036     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA037     | 2013 | Milne Inlet, NU      | JM Hillier, Gretchen Freund |
| ECA038     | 2013 | Eclipse Sound, NU    | Gretchen Freund             |



| Individual | Year | Location              | Photographer                  |
|------------|------|-----------------------|-------------------------------|
| ECA039     | 2013 | Eclipse Sound, NU     | Gretchen Freund               |
| ECA040     | 2013 | Milne Inlet, NU       | JM Hillier, Gretchen Freund   |
| ECA041     | 2013 | Eclipse Sound, NU     | Gretchen Freund               |
| ECA042     | 2017 | Eclipse Sound, NU     | Claire Hornby                 |
| ECA043     | 2017 | Tremblay Sound, NU    | Max Bakken                    |
|            | 2019 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA044     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA045     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA046     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA047     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA048     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA049     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA050     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA051     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA052     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA053     | 2018 | Milne Inlet, NU       | Cory Matthews, Yuuki Watanabe |
| ECA054     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA055     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA056     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
|            | 2020 | Cumberland Sound, NU* | Ricky Kilabuk                 |
| ECA057     | 2018 | Eclipse Sound, NU     | Maha Ghazal, Kyle Lefort      |
| ECA058     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA059     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA060     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA061     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA062     | 2018 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA063     | 2019 | Eclipse Sound, NU     | Maha Ghazal                   |
| ECA064     | 2019 | Eclipse Sound, NU     | Maha Ghazal                   |

\*Note that whales recorded in Cumberland Sound, NU are included in Section 4.2, however this sighting was included in this table since the individual was first observed within the Tallurutiup Imanga study area.

| Individual | Year | Location          | Photographer    |
|------------|------|-------------------|-----------------|
| ECA065     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA066     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA067     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA068     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA069     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA070     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA071     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA072     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA073     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA074     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA075     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA076     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA077     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA078     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA079     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA080     | 2019 | Eclipse Sound, NU | Maha Ghazal     |
| ECA081     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA082     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA083     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA084     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA085     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA086     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA087     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA088     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA089     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA090     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA091     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA092     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA093     | 2020 | Eclipse Sound, NU | Enookie Inuarak |
| ECA094     | 2020 | Eclipse Sound, NU | Enookie Inuarak |

## 5.2 CUMBERLAND SOUND

| Individual | Year | Location             | Photographer  |
|------------|------|----------------------|---------------|
| ECA095     | 2011 | Cumberland Sound, NU | David Kilabuk |
| ECA096     | 2011 | Cumberland Sound, NU | David Kilabuk |
| ECA097     | 2011 | Cumberland Sound, NU | David Kilabuk |
| ECC098     | 2011 | Cumberland Sound, NU | David Kilabuk |
| ECA099     | 2011 | Cumberland Sound, NU | David Kilabuk |
| ECA100     | 2011 | Cumberland Sound, NU | David Kilabuk |
| ECA101     | 2020 | Cumberland Sound, NU | Ricky Kilabuk |
| ECA102     | 2020 | Cumberland Sound, NU | Ricky Kilabuk |

## 6. ACKNOWLEDGEMENTS

This catalogue was assembled as part of Orcas of the Canadian Arctic (OCA) research program. We would like to thank all the photographers who contributed photographs to the OCA project, including Gretchen Freund, Max Bakken, Paul Prior, JM Hillier, Jess Taunton and Chris Bray, Nate Small, Jack Putman, Claire Hornby, Maha Ghazal, Yuuki Watanabe and David Kilabuk, authors Kyle Lefort and Cory Matthews, and others who contributed photographs not used in the catalogue. We would like to thank the communities of Pond Inlet, Arctic Bay, and Pangnirtung, and in particular Enookie Inuarak, Michael Inuarak, Owen Jawrenko, Jamie Erkloo, David Suqslak, Ricky Kilabuk, Eric Kilabuk, and Mark Kilabuk, who assisted with fieldwork. We would also like to thank Adrien Laydevant, Fernando Ugarte, Georgina Cabayol, and Arlene Erven for sharing photographs of other populations for comparison, and Graeme Ellis for his insights and advice. Finally, we thank Jared Towers and Brent Young for review. Funding was provided by the Nunavut Implementation Fund, Nunavut Wildlife Management Board, Nunavut General Monitoring Plan, Fisheries and Oceans Canada, NSERC, Species at Risk Act, and WWF Canada.

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## APPENDIX 1: LEFT SIDE PHOTOGRAPHS

This appendix includes left-side photographs of killer whales sighted in the Tallurutiup Imanga NMCA and surrounding area between 2009 and 2020, or Cumberland Sound in 2011 and 2020. Individuals included in this appendix could not be matched to individuals with right-side photographs included in Section 3. Therefore, they may be new individuals (of which a right-side photograph was not taken), or left-side photographs of individuals that were included in Section 3 but could not be matched due to a lack of unique features identifiable from both sides (such as nicks in the fin). Since we cannot be certain that there are no repeated individuals from Section 3, we have included unmatched left-side photographs here.

Methods of photograph collection, photographic analysis, and identification are described in Section 2. There are a total of 47 individual left-side photographs. The identification code includes 'LS', for 'left-side', and the order in which they were identified (e.g., LS001). The panel below the photograph also includes the location and year in which the photograph was taken.

### CATALOGUE



LS001

Admiralty Inlet 2009



LS002

Admiralty Inlet 2009



LS003

Admiralty Inlet 2010



LS004

Lancaster Sound 2013



LS005

Lancaster Sound 2013



LS006

Lancaster Sound 2013



LS007

Milne Inlet 2013



LS008

Milne Inlet 2013



LS009

Tremblay Sound 2017



LS010

Milne Inlet 2018





LS011

Milne Inlet 2018



LS012

Eclipse Sound 2018



LS013

Eclipse Sound 2018



LS014

Eclipse Sound 2018



LS015

Eclipse Sound 2018



LS016

Eclipse Sound 2018



LS017

Eclipse Sound 2018



LS018

Eclipse Sound 2018



LS019

Eclipse Sound 2018



LS020

Eclipse Sound 2018



LS021

Eclipse Sound 2018



LS022

Eclipse Sound 2018





LS023

Eclipse Sound 2018



LS024

Eclipse Sound 2019



LS025

Eclipse Sound 2019



LS026

Eclipse Sound 2019



LS027

Eclipse Sound 2019



LS028

Eclipse Sound 2019



LS029

Eclipse Sound 2019



LS030

Eclipse Sound 2019



LS031

Eclipse Sound 2019



LS032

Eclipse Sound 2019



LS033

Eclipse Sound 2019



LS034

Eclipse Sound 2019





LS035

Eclipse Sound 2019



LS036

Eclipse Sound 2020



LS037

Eclipse Sound 2020



LS038

Eclipse Sound 2020



LS039

Eclipse Sound 2020



LS040

Eclipse Sound 2020



LS041

Eclipse Sound 2020



LS042

Eclipse Sound 2020



LS043

Eclipse Sound 2020



LS044

Eclipse Sound 2020



LS045

Cumberland Sound 2011



LS046

Cumberland Sound 2020



LS047

Cumberland Sound 2020