Photo-identification Catalogue and Status of the Northern Resident Killer Whale Population in 2019

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PHOTO-IDENTIFICATION CATALOGUE AND STATUS OF THE NORTHERN RESIDENT KILLER WHALE POPULATION IN 2019

by

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ABSTRACT

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Censuses of the northern resident killer whale population using photo-identification have been conducted annually since 1973. These studies are based on photographic recapture of permanent natural markings on every individual within the population. In this report, we summarize northern resident killer whale population trends over the time series of this study and provide a photo-identification catalogue of all individuals considered to be alive in 2019. This population has grown at a mean annual rate of 2.2% since 1973 and in 2019 contained a minimum of 310 individuals. Continued annual photo-identification censusing is a key strategy to accurately document the abundance, genealogy, sociality, demographics, and health of this threatened population.

RÉSUMÉ

Towers, J.R., Pilkington, J.F., Gisborne, B., Wright, B.M., Ellis, G.M., Ford, J.K.B., and Doniol-Valcroze, T. 2020. Photo-identification catalogue and status of the northern resident killer whale population in 2019. Can. Tech. Rep. Fish. Aquat. Sci. 3371: iv + 69 p.

Des recensements de la population d’épaulards résidents du nord ont été menés tous les ans depuis 1973. Ces études reposent sur l'identification de chacun des individus à partir de photographies de marques naturelles permanentes. Dans le présent rapport, nous résumons les tendances démographiques de la population d'épaulards résidents du nord pour toute la durée de l’étude, et présentons un catalogue de photographies d'identification des individus considérés comme étant en vie en 2019. Le taux d’accroissement moyen de cette population est de 2,2% par an depuis 1973, avec un minimum de 310 individus en 2019. Le maintien d’un recensement photographique annuel constitue une stratégie essentielle pour documenter l’abondance, la généalogie, la vie sociale, la démographie et la santé de cette population menacée.

1.0 INTRODUCTION

Killer whales in the coastal waters of British Columbia were first found to be individually recognizable in 1970 (Spong et al. 1970). Field research using photo-identification began on these killer whales in 1973 (Bigg et al. 1976) and continues to the present. Over this time period, photo-identification data has been fundamental in defining killer whale populations in British Columbia (Bigg 1982; Ford and Ellis 1999; Ford et al. 1994, 2000), determining their social structure (Bigg et al. 1990; Olesiuk et al. 1990), distribution and abundance (Ellis et al. 2011; Ford et al. 2014; Towers et al. 2019), and facilitating studies on their behaviours (Morton 1990; Baird and Dill 1995; Barrett-Lennard et al. 1996; Ford and Ellis 2006; Ford et al. 1998, 2011; Deecke et al. 2010; Wright et al. 2017; Towers et al. 2018), cultures and evolution (Riesch et al. 2012; Foster et al. 2012; Wright et al. 2016; Whitehead and Ford 2018).

Three ecotypes of killer whale occupy coastal waters off western Canada – residents, Bigg's, and offshores. Each of these ecotypes are unique in their morphology and ecology (Ford 2014). Although their ranges overlap, they do not mix socially and as a result, are reproductively isolated and genetically distinct (Barrett-Lennard 2000). In BC, the resident ecotype is composed of two populations that do not intermingle. Named northern and southern for their usual distribution in relation to each other along the BC coast, both populations range from southeastern Alaska to outer coast waters off the continental US (Ford et al. 2017).

The northern and southern resident killer whale communities are composed of several groups of maternally related individuals that maintain social cohesion over long time periods (Ford et al. 2000). These social groups, initially referred to as pods and subpods (Bigg et al. 1987), are now more commonly referred to as matrilines (Towers et al. 2015). They can contain up to five generations of living individuals (see R5 matriline in Appendix) and are typically composed of an older female, all her offspring, all the offspring of her daughters and so forth. Every individual within each matriline shares a socially learned dialect. The northern resident killer whale community contains three acoustic clans, each containing matrilines with acoustic similarities and thus, common maternal ancestry (Ford 1991).

Northern resident killer whales have a strong preference for large salmon, primarily Chinook and secondarily, chum (Ford et al. 2010; Ford and Ellis 2006). Their health, survival, and fecundity are correlated with the availability and size of these prey (Ford et al. 2010; Groskreutz et al. 2019; Murray et al. 2019). Other historic, current, or emerging threats include live-captures (Bigg and Wolman 1975), intentional shootings (Hoyt 2019; DFO unpubl. data), acute and chronic acoustic disturbance (Morton and Symonds 2002; Williams et al. 2013), vessel strikes (Williams and O'Hara 2010; Murray et al. 2019), entanglement and ingestion of fishing gear (Fisheries and Oceans Canada 2018), and bioaccumulation of contaminants (Ross et al. 2000). These threats,

combined with relatively small population size and low reproductive rates (Olesiuk et al. 2005), led to this population being listed as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 2001 and subsequently under Canada's Species at Risk Act (SARA). Objectives for the improvement of our understanding and conservation of this population are provided in the Resident Killer Whale Recovery Strategy (Fisheries and Oceans Canada 2018). Among them, the annual photo-identification census is listed as a key technique because most efforts taken to recover the population are underpinned by knowledge of population health and size.

Photo-identification data from annual censuses of northern residents have been published periodically in books and technical reports to provide up-to-date working documents that present details on the evolving appearances, demographics, size, and growth trends of the population (Bigg et al. 1987; Ford et al. 1994, 2000; Ellis et al. 2007, 2011; Towers et al. 2015). In this report we provide an update on the size of the northern resident killer whale population in 2019, its annual growth rate since 1973, and an updated photo-identification catalogue of all individuals considered alive in 2019.

2.0 MATERIALS AND METHODS

2.1 DATA COLLECTION

Digital identification photographs of northern resident killer whale dorsal fins and saddle patches were collected perpendicular to the whales' left sides from small boats using methods first described by Bigg et al. (1976, 1986) and later updated by Ellis et al. (2011).

2.2 DEFINING AGE, SEX, AND DEATH

Birth years for northern resident killer whales first documented as adults were estimated based on known or inferred ages of their known or inferred kin (Bigg et al. 1990). Years of birth for individuals first documented as juveniles or calves were assigned based on the size of the whale when it was first documented. Individuals were only considered dead after being absent from several encounters with their closest kin or preferred travel partners (Olesiuk et al. 2005).

Sexes were confirmed visually in the field from observations of skin pigmentation on the underside of the body, dorsal fin growth (sprouting males), close association with newborn offspring (reproductive females), or DNA from genetic samples (DFO 2019). If an animal of unknown sex reaches 15 years of age without sprouting or producing a calf, it is assumed to be female until otherwise confirmed.

2.3 NAMING

Individuals are named with an alphanumeric designation based on the letter of the pod they belong to and the order in which they were first identified. Matrilines are named after the eldest living reproductive female within a group of maternally related individuals, although if she has a surviving brother or uncle, the matriline is named after the deceased mother of the eldest male (Towers et al. 2015). Pod names refer to the most distinctive whale documented in each social group when they were first identified in the early 1970s (Bigg et al. 1987). Each clan bears the same letter as the most abundant pod within it.

2.4 DATA ANALYSIS

Identification metadata were individually applied to all images of northern resident killer whales on an annual basis as per data analysis and management techniques provided in Towers et al. (2012). Population size was calculated as the minimum number of individuals alive each year, assuming that all whales missing from censused matrilines were dead and that all uncensused individuals were alive (DFO 2019).

2.5 DATA PRESENTATION

The appendix includes identification photographs of whales known or presumed to be alive at the end of the 2019 field season with the inclusion of two individuals (I26 and I42) considered missing in 2019. Individuals are laid out by generation, in order of birth, and in relation to maternal kin. Clusters often represent socially cohesive groups, however, some individuals may or may not exhibit social cohesion with others in their matriline (Ford and Ellis 2002; Towers et al. 2015). Tabs are provided on the outside edge of each page indicating the acoustic clan to which each group belongs. Schematic diagrams portray matrilineal genealogical relationships that have been inferred from long-term observations of social associations (Bigg et al. 1987; Ford et al. 1994, 2000; Ellis et al. 2007, 2011; Towers et al. 2015). They include every individual documented over the course of the study with the exception of matrilines that no longer contain any living members. Clear boxes represent individuals known or presumed to be alive in 2019 and shaded boxes represent deceased individuals. Known or estimated birth years are listed above each identification photograph and below each shaded box. If known, sexes are indicated with symbols above each identification photograph and within each schematic box. Lines linking mothers and offspring are solid if the relationship is positive (i.e., known with certainty). This includes individuals that have been documented since birth. Relationships between whales born before the study began in the early 1970s are not known with certainty and are either probable, indicated by a dashed line, or possible, indicated by a dotted line.

3.0 RESULTS AND DISCUSSION

Since the last northern resident killer whale photo-identification catalogue and population update was published in 2015 (Towers et al. 2015) we have traveled several

thousand kilometres each year in search of northern resident killer whales. We located them an average of 60 times per year (range: 39-82) and analyzed a total of 51,696 identification photos between 2015 and 2019. These are similar levels of effort, encounters, and data as in previous census years (Bigg 1982; Ellis et al. 2011; Towers et al. 2015).

Complete accounting of all northern resident killer whales within a census year is rare. As a result, there is occasionally some uncertainty in the total population size in a given year. Between 2015 and 2019 we accounted for all northern resident killer whales at an average of 93% (range: 83%- 99%) of the population each year. Any uncertainty in statuses of individuals in a matriline were typically clarified whenever that matriline was next encountered. In 2019, one matriline (R17) was not encountered, but assuming all 12 individuals within it were alive, the minimum population size for northern resident killer whales was 310 individuals (range: 310-314).

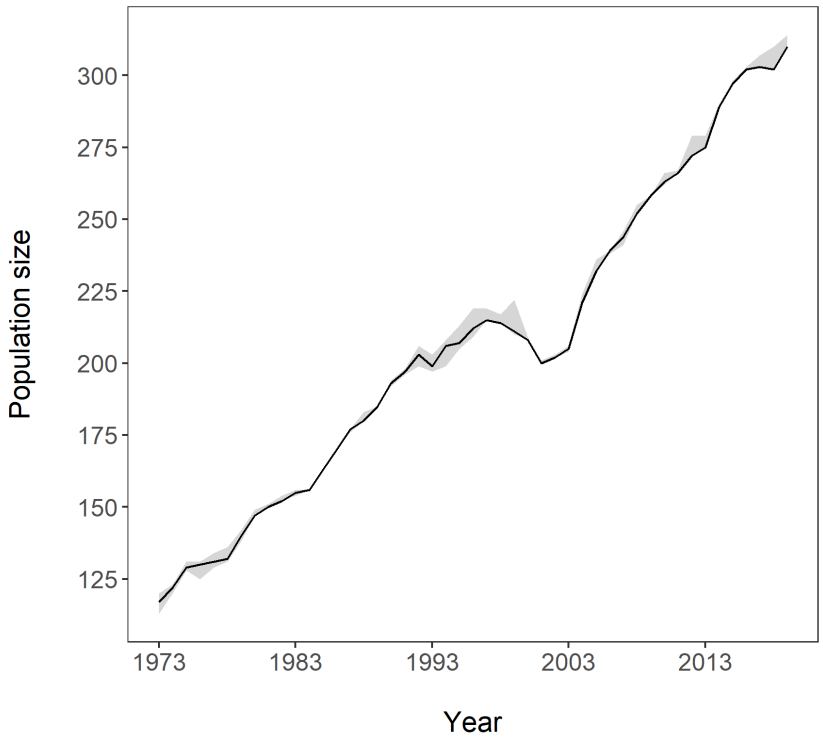

Figure 1. Abundance trend of the northern resident killer whale population from 1973-2019. Uncertainties in minimum and maximum population sizes are represented with shading.

Between 1973 and 2019, the northern resident killer whale population experienced periods of both growth and decline (Figure 1). The 7% decline in population size between 1998 and 2001 coincided with a reduction in the abundance of

primary prey for this population, Chinook salmon (Ford et al. 2010). Immature individuals that survived this period experienced constrained growth and have significantly shorter maximum body lengths than individuals that matured before this decline (Groskreutz et al. 2019). Since 2002, no annual decline in total numbers was documented until 2018 when the northern resident population showed a growth rate of -0.3% (DFO 2019).

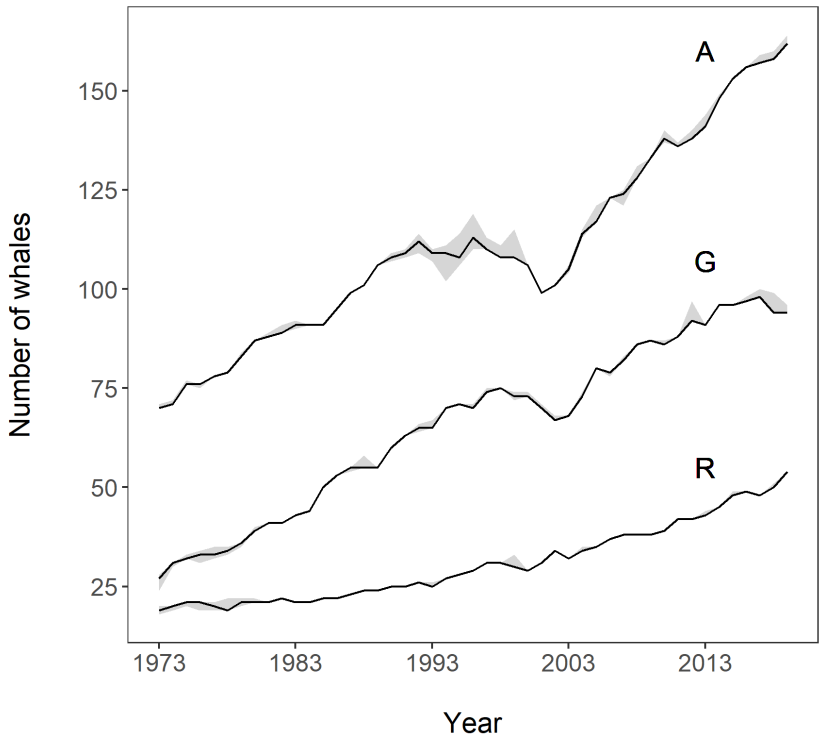

Figure 2. Abundance trends of the northern resident killer whale clans from 1973-2019. Uncertainties in minimum and maximum population sizes are represented with shading.

The mean rate of annual growth for the northern resident population over the time series of this study is 2.2%. G clan had the greatest mean annual growth rate of 2.8%, followed by R clan at 2.4% and A clan at 1.9% (Figure 2). However, over the last five years G clan has shown the lowest annual mean growth rate (-0.2%), followed by A clan (2.2%) and R clan (4.0%). These trends are likely influenced by a suite of factors from changing demographics within each clan to the availability of preferred prey and the ability of individuals to withstand both chronic and acute threats within their environment. Continued population censusing using photo-identification will continue to improve our understanding of northern resident killer whale population health and the impacts that anthropogenically and environmentally influenced changes may have on it.

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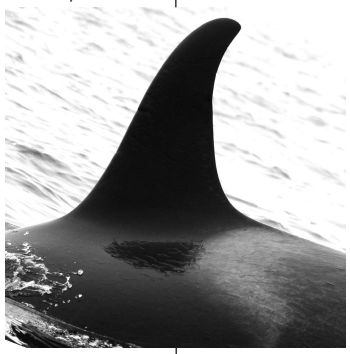
APPENDIX

Photo-identification catalogue of northern resident killer whales

A1 Pod,
A34 Matriline

A55 ♂ 1990

A62 ♀ 1994



A83 ♂ 2005

A91 ♂ 2009

A107 ♂ 2013

A34 ♀ 1975

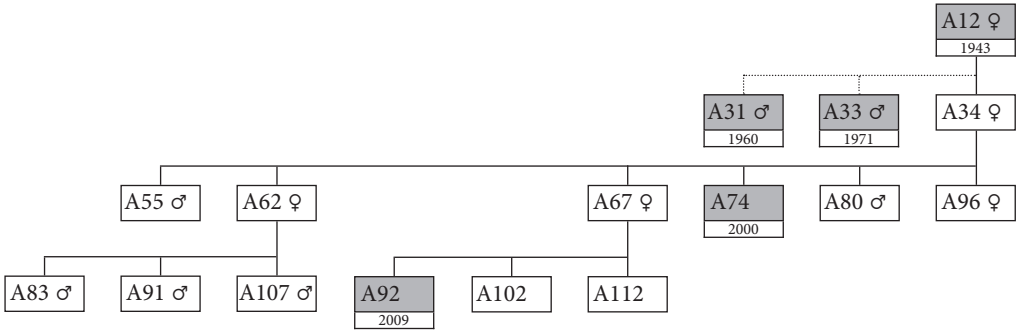
A67 ♀ 1997

A80 ♂ 2004

A96 ♀ 2010

A102 2012

A112 2016



A1 Pod,
A50 Matriline

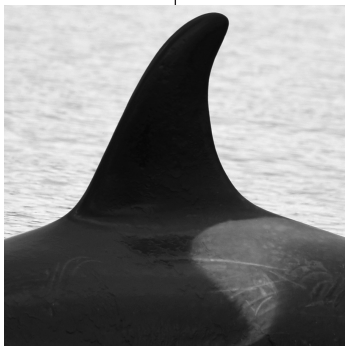
A50 ♀ 1984

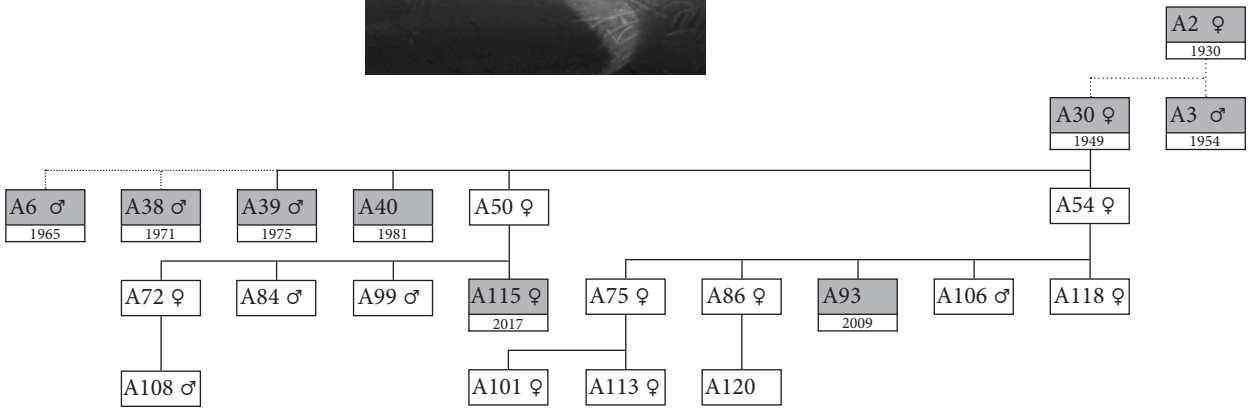
A72 ♀ 1999

A84 ♂ 2005

A99 ♂ 2011

A108 ♂ 2014





A1 Pod,
A54 Matriline

A54 ♀ 1989

A75 ♀ 2002

A86 ♀ 2006

A106 ♂ 2013

A118 ♀ 2018

A101 ♀ 2012

A113 ♀ 2016

A120 2019

A4 Pod,
A35 Matriline

A52 ♀ 1987

A70 ♀ 1999

A81 ♂ 2004

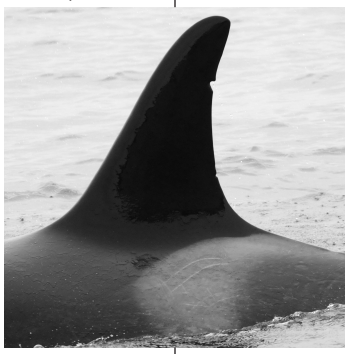
A105 2013

A100 2011

A111 2016

A4 Pod, **A56 Matriline**

A35 ♀ 1974

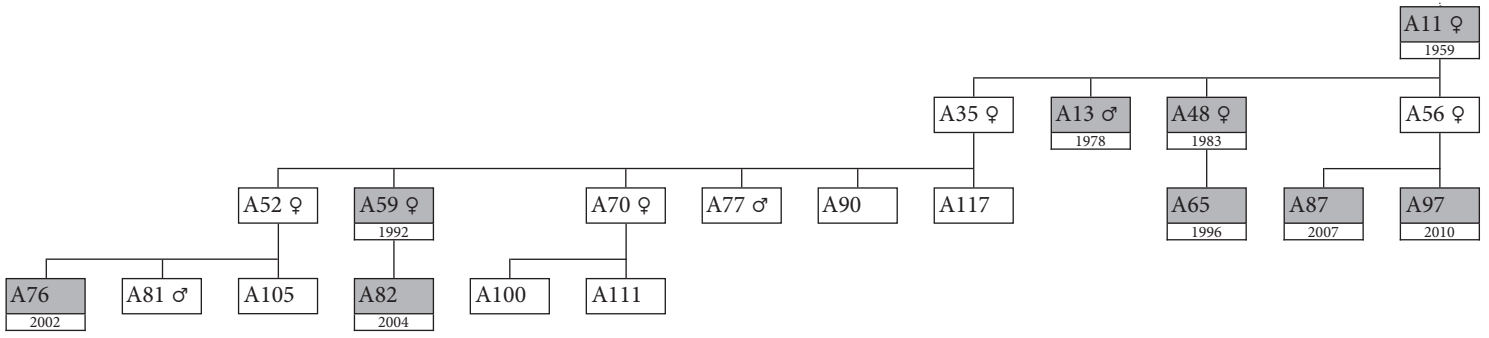


A56 ♀ 1990

A77 ♂ 2003

A90 2008

A117 2017



A4 Pod,
A24 Matriline

A73 ♀ 2000

A104 2013

A116 2017

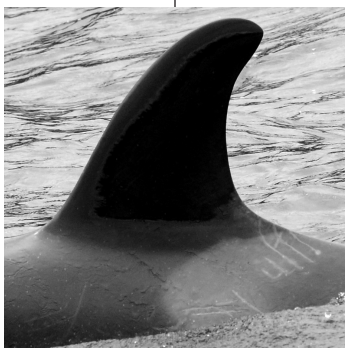
A64 ♀ 1995

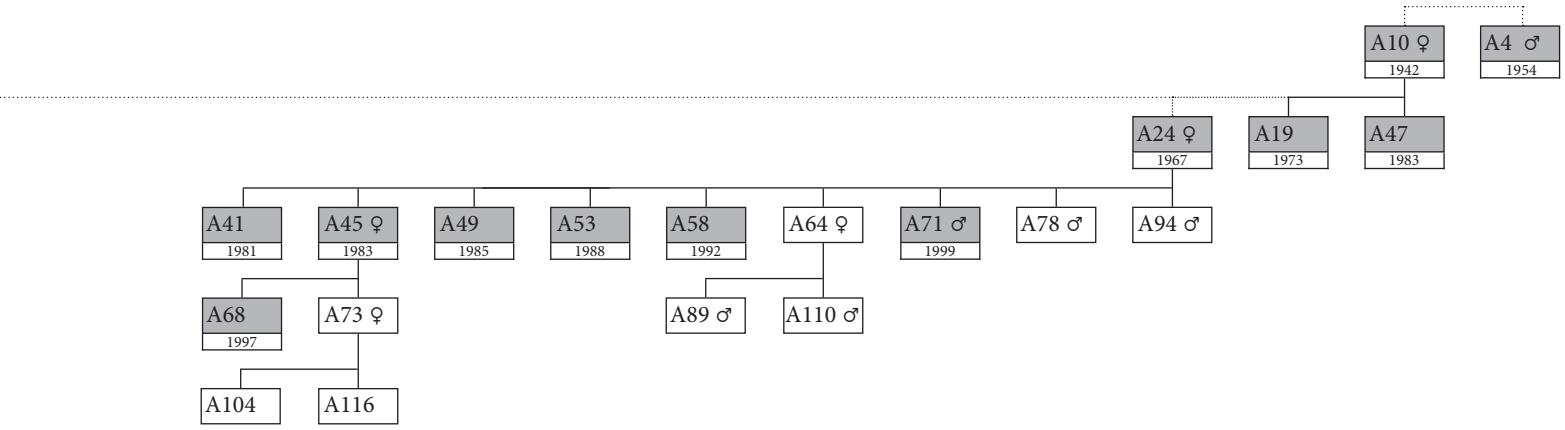
A78 ♂ 2003

A94 ♂ 2009

A89 ♂ 2008

A110 ♂ 2015

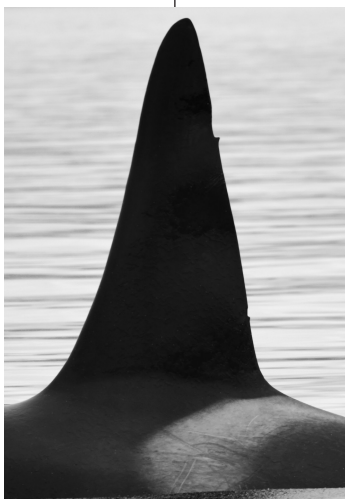




A5 Pod,
A23 Matriline

A43 ♀ 1981

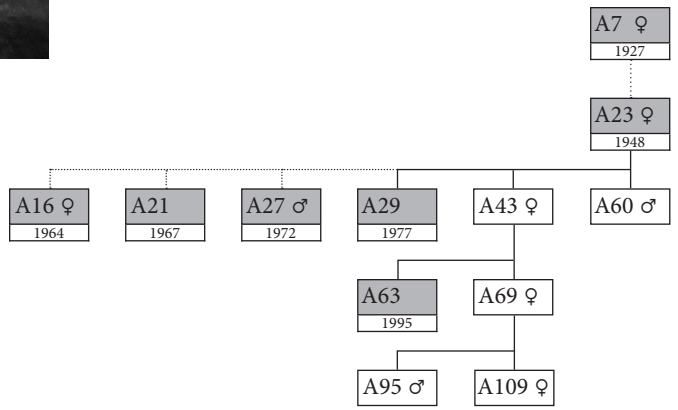
A60 ♂ 1992



A69 ♀ 1997

A95 ♂ 2009

A109 ♀ 2014

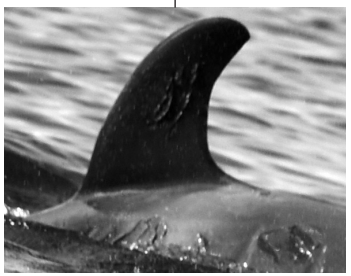


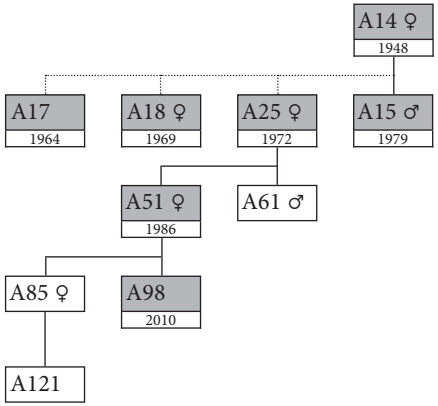
A5 Pod,
A25 Matriline

A61 ♂ 1994

A85 ♀ 2005

A121 2019





A5 Pod,
A42 Matriline

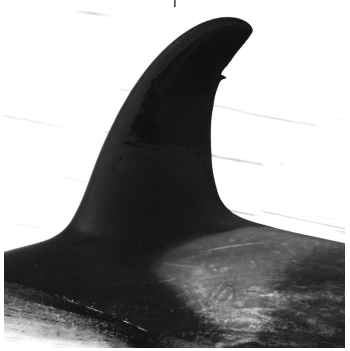
A42 ♀ 1980

A66 ♂ 1996

A79 ♀ 2004

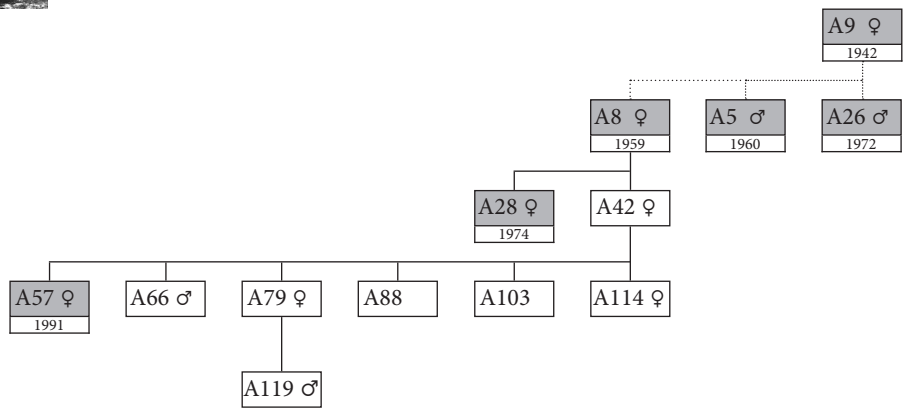
A88 2008

A103 2013



A114 ♀ 2017

A119 ♂ 2018



B1 Pod,
B7 Matriline

B7 ♀ 1949

B10 ♂ 1979

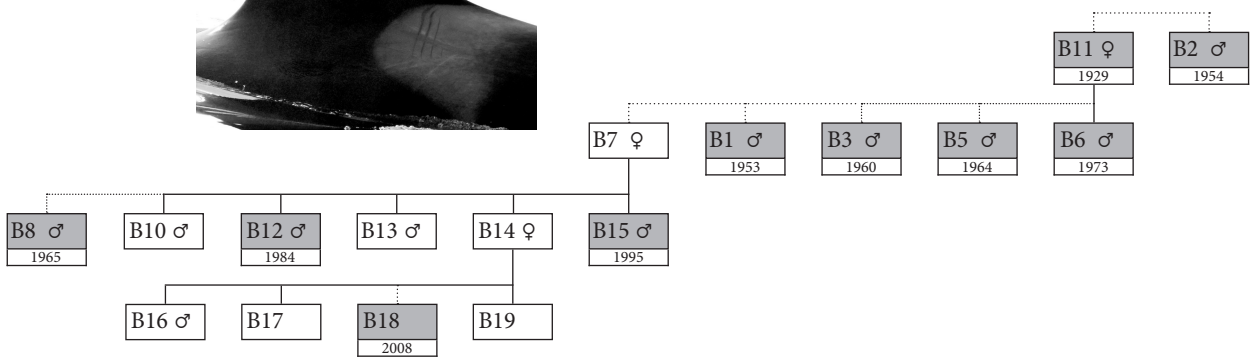
B13 ♂ 1987

B14 ♀ 1991

B16 ♂ 2004

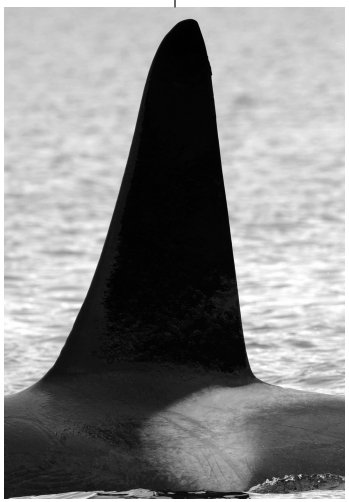
B17 2008

B19 2014



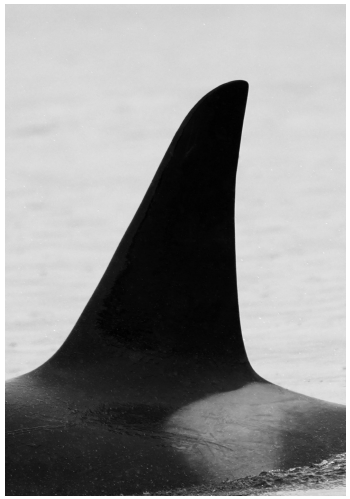
C1 Pod,
C6 Matriline

C16 ♂ 1989



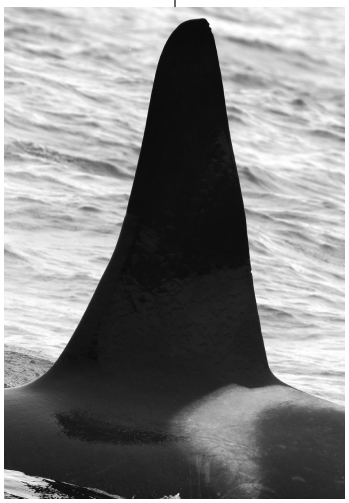
C31 2009

C27 ♂ 2006

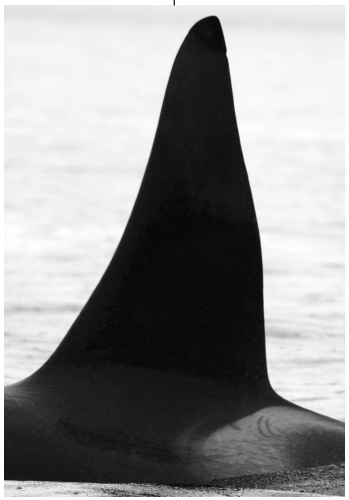


C8 ♀ 1975

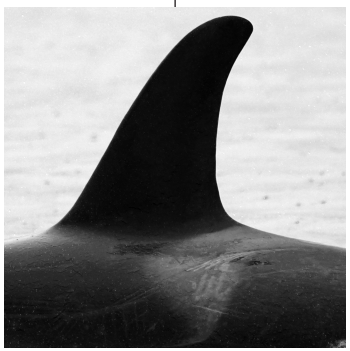
C14 ♂ 1985

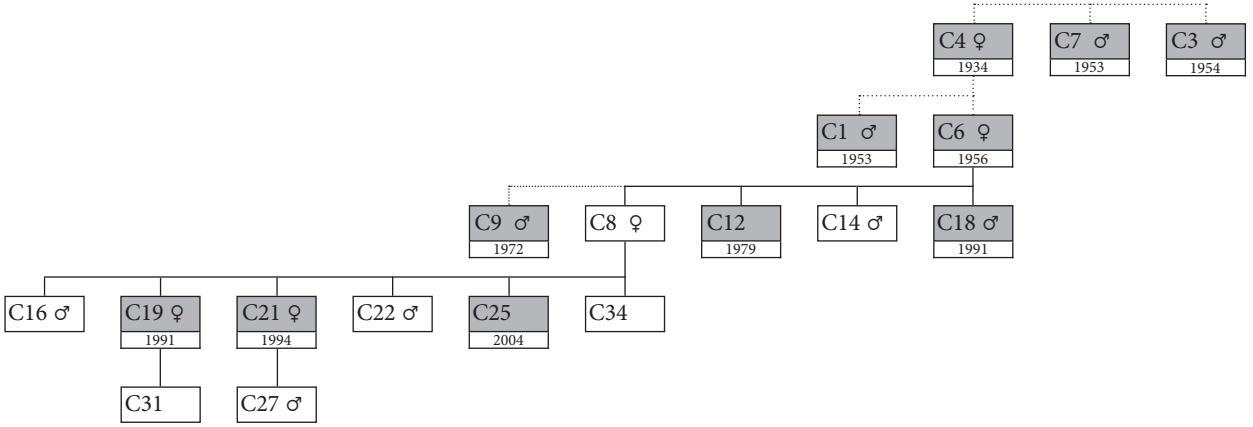


C22 ♂ 1997



C34 2013





C1 Pod,
C10 Matriline

C13 ♀ 1985

C28 2007

C32 2013

C36 2019

C10 ♀ 1972

C23 ♀ 1998

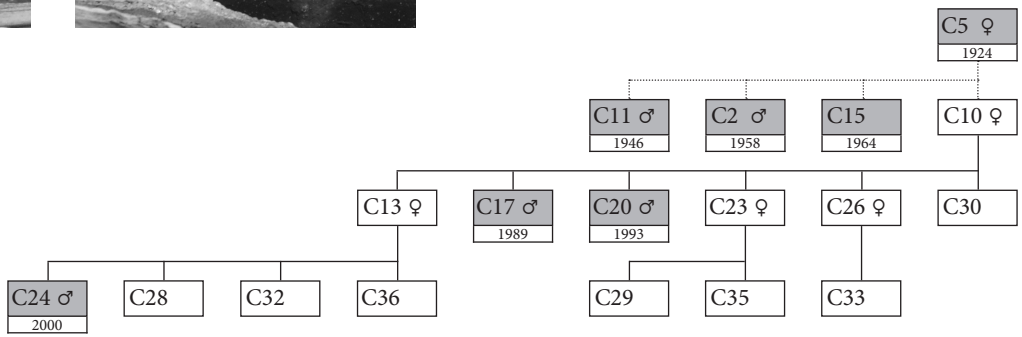
C26 ♀ 2004

C30 2009

C29 2009

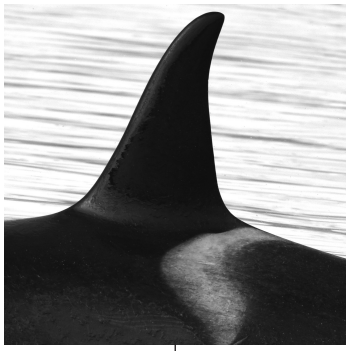
C35 2015

C33 2014



D1 Pod,
D12 Matriline

D12 ♀ 1982

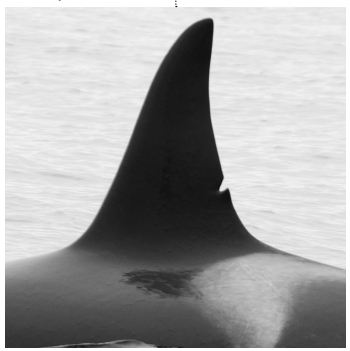


D20 ♀ 1999

D29 ♂ 2014

D1 Pod,
D9 Matriline

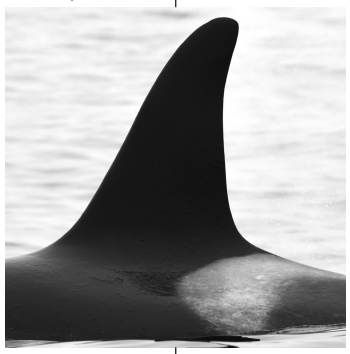
D9 ♀ 1972



Since the death of C19, C31 has been travelling with D9.

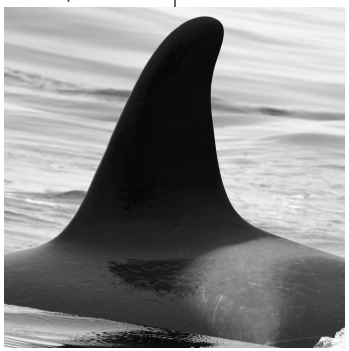
D1 Pod,
D13 Matriline

D13 ♀ 1984



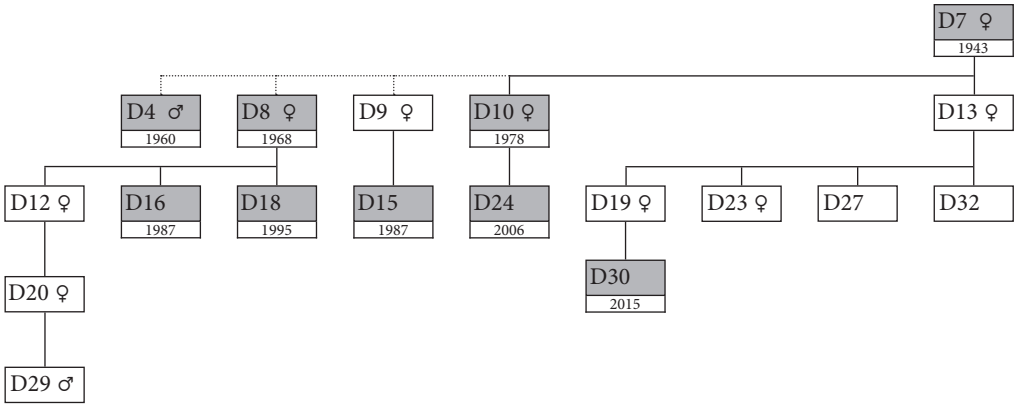
D19 ♀ 1998

D23 ♀ 2005



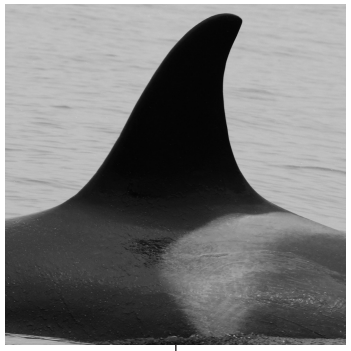
D27 2012

D32 2018



D1 Pod,
D11 Matriline

D11 ♀ 1975



D17 ♀ 1990

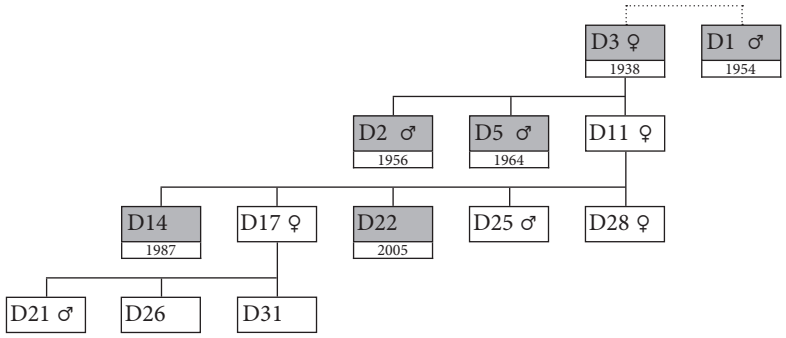
D25 ♂ 2007

D28 ♀ 2013

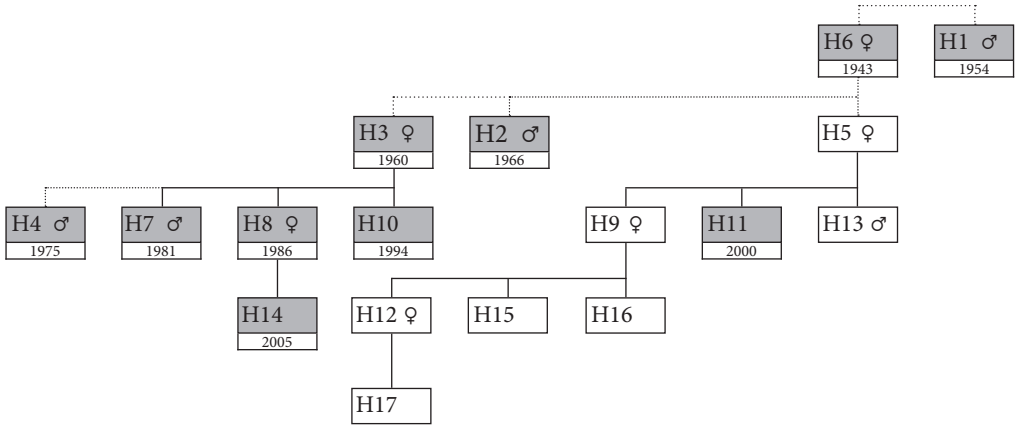
D21 ♂ 2005

D26 2010

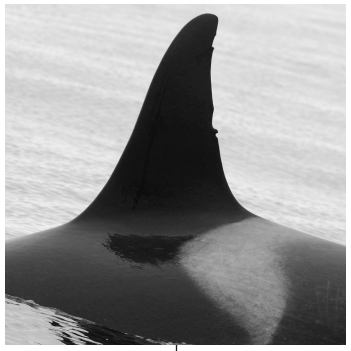
D31 2015



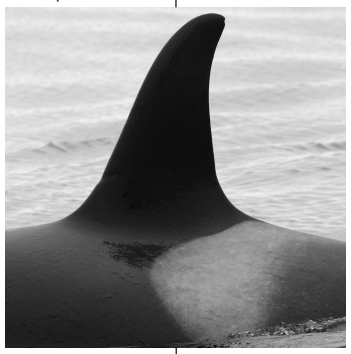
H1 Pod,
H5 Matriline



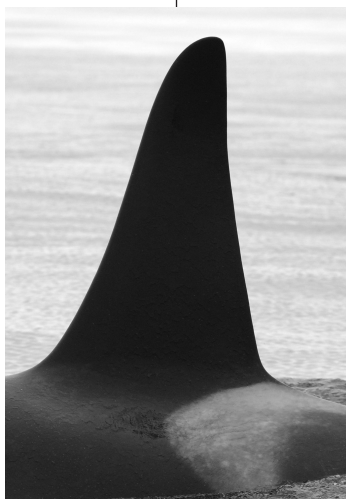
H5 ♀ 1973



H9 ♀ 1988



H13 ♂ 2004



H12 ♀ 2002

H15 2008

H16 2012

H17 2013

I1 Pod,
I19 Matriline

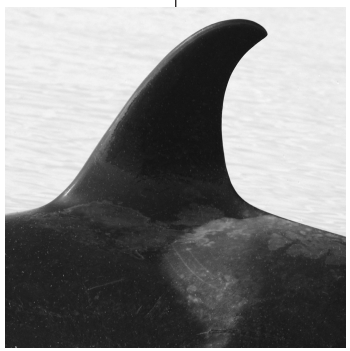
The I19 matriline does not always travel as a cohesive group.

I54 ♀ 1983

I71 ♀ 1993

I97 ♂ 2002

I142 2013



I112 ♂ 2006

I131 2010

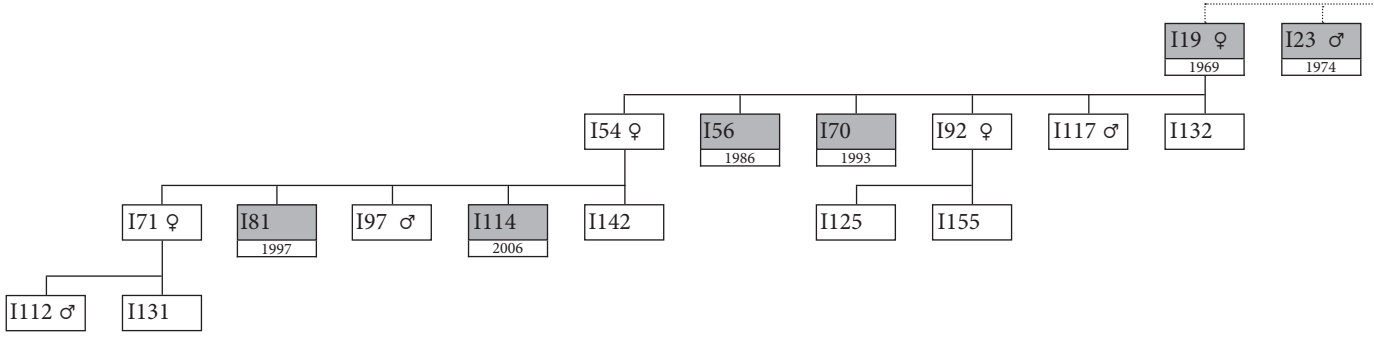
I92 ♀ 1999

I117 ♂ 2005

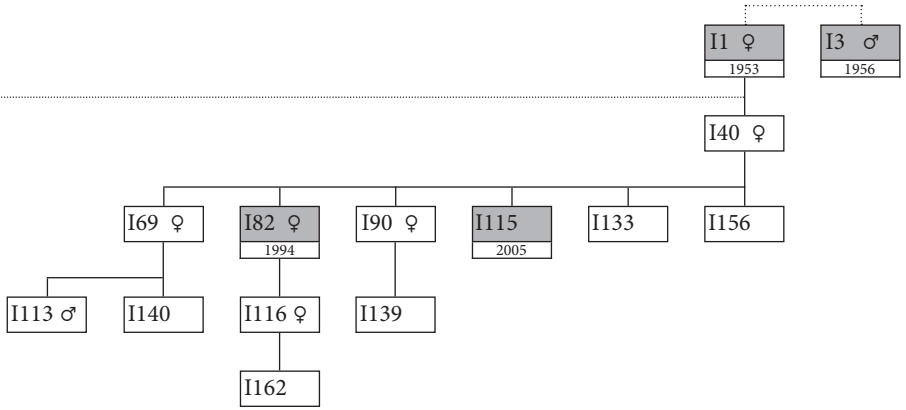
I132 2010

I125 2008

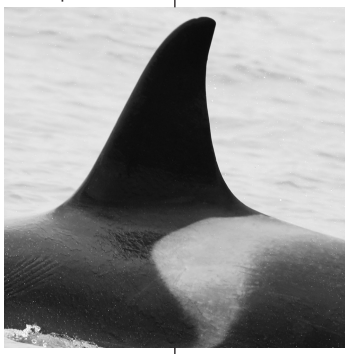
I155 2017



I1 Pod,
I40 Matriline



I69 ♀ 1991



I113 ♂ 2006

I140 2013

I116 ♀ 2006

I162 2019

I2 Pod,
I22 Matriline

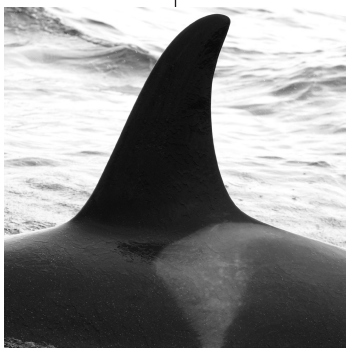
Individuals in the I40 matriline are not always found together.

I40 ♀ 1980

I22 ♀ 1966

I90 ♀ 1999

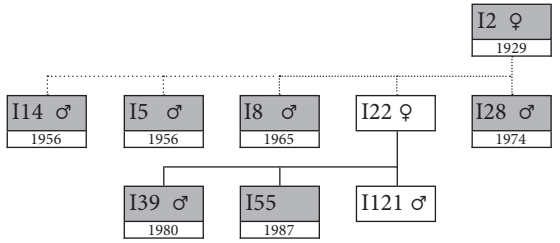
I133 2010



I156 2017

I121 ♂ 2007

I139 2012

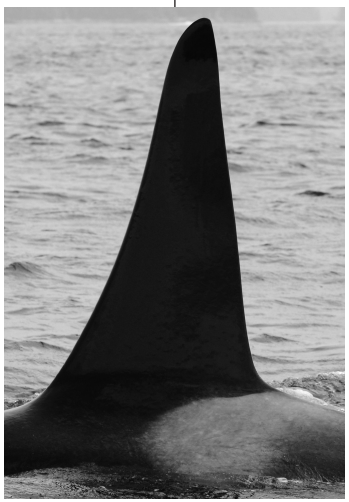


I18 Pod,
I17 Matriline

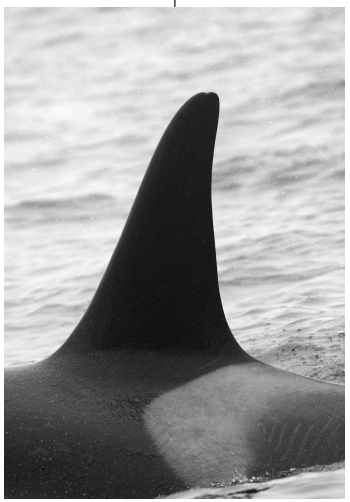
I26 ♀ 1975

I93 ♂ 1992

I91 ♂ 1996



I118 ♂ 2006



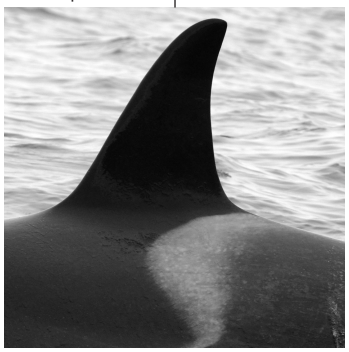
I148 2014

I50 and her offspring are not always found with the rest of the I17 matriline.

I50 ♀ 1983

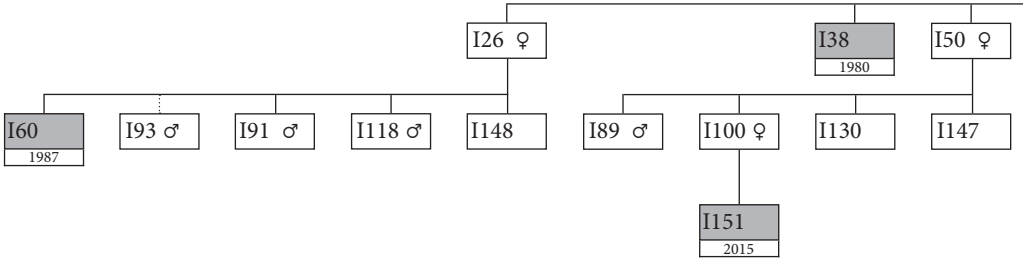
I89 ♂ 1996

I100 ♀ 2003



I130 2010

I147 2014



I18 Pod,
I17 Matriline
continued

I17 ♀ 1960

I57 ♀ 1989

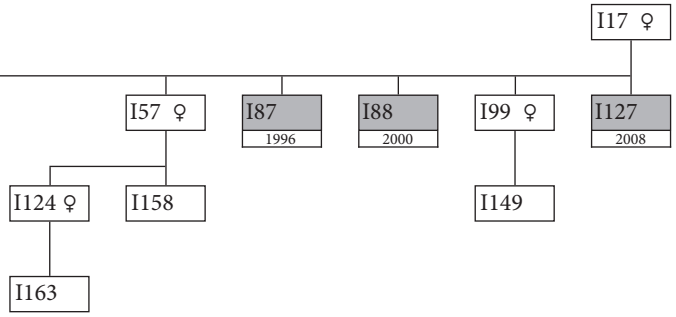
I99 ♀ 2003

I124 ♀ 2007

I158 2016

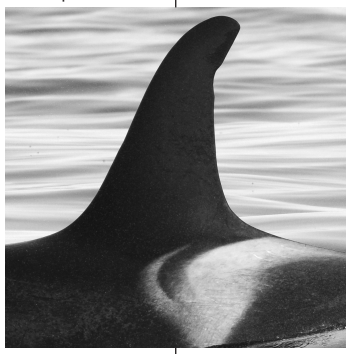
I149 2014

I163 2019



I18 Pod,
I18 Matriline

I21 ♀ 1979



I119 ♂ 2006

I134 2010

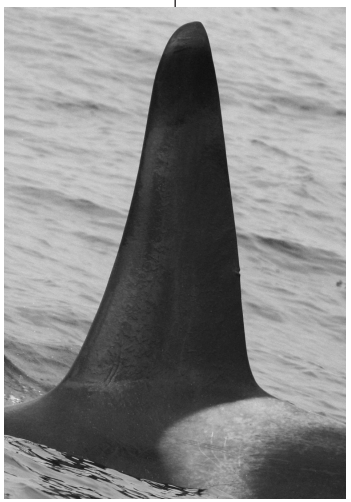
I150 2014

I157 2018

I18 Pod,
I18 Matriline
continued

I20 ♀ 1965

I52 ♂ 1986



I83 ♀ 1997

I101 ♂ 2003

I126 ♀ 2008

I141 2013

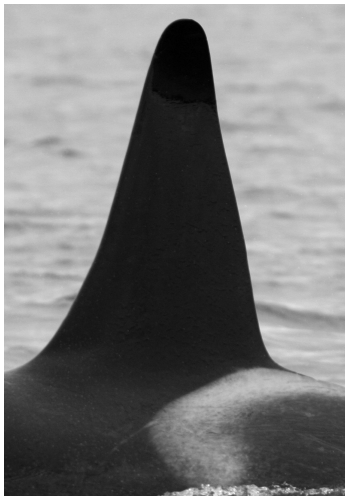
I160 2019

I24, her progeny, and I53 do not often travel with others in the I18 matriline.

I24 ♀ 1980

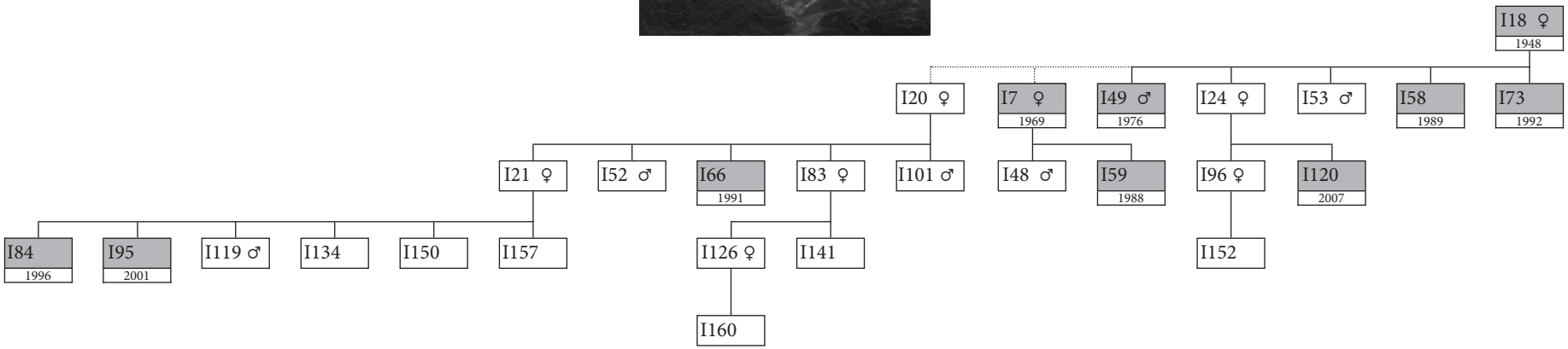
I53 ♂ 1986

I48 ♂ 1983

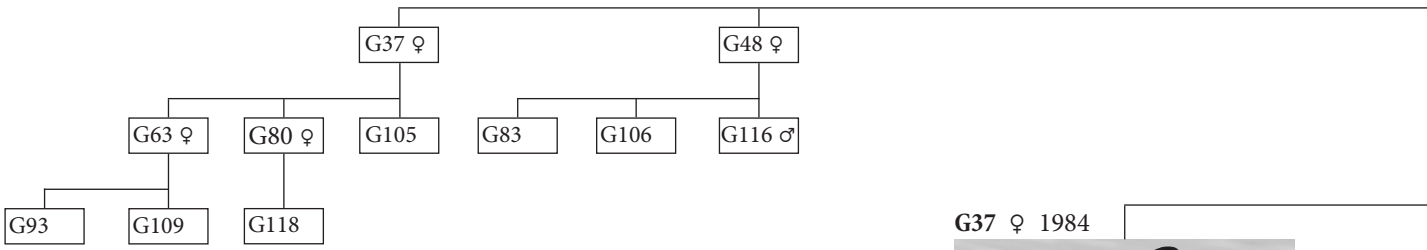


I96 ♀ 2002

I152 2015



G1 Pod,
G3 Matriline



G37 ♀ 1984

G63 ♀ 1999

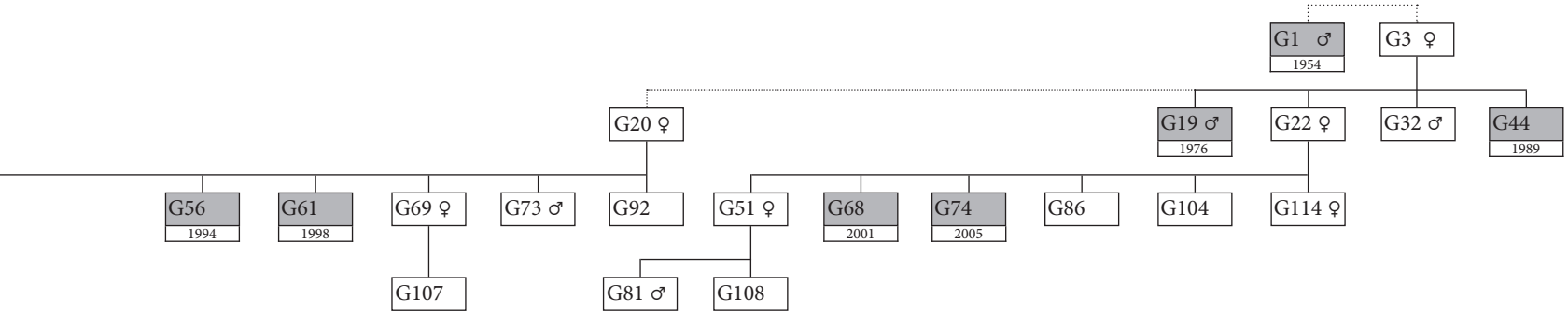
G80 ♀ 2006

G105 2012

G93 2010

G109 2015

G118 2019



G37, G48, and their progeny are sometimes observed separate from others in the G20 lineage.

G48 ♀ 1990

G83 2007

G106 2013

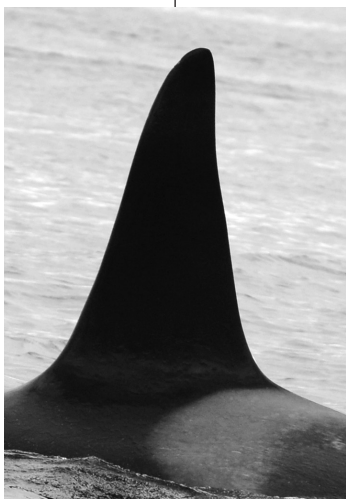
G116 ♂ 2018

G1 Pod,
G3 Matriline
continued

G20 ♀ 1972

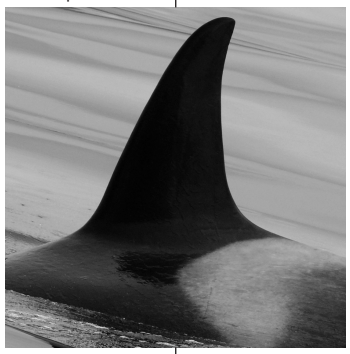
G69 ♀ 2001

G73 ♂ 2004



G92 2009

G51 ♀ 1992



G107 2014

G81 ♂ 2006

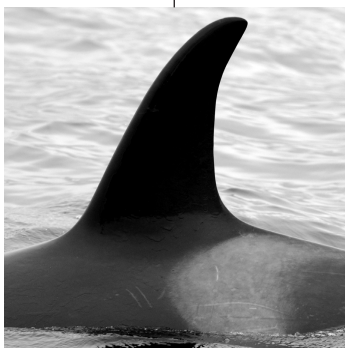
G108 2014

G22 and her progeny do not always travel with others in the G3 matriline.

G22 ♀ 1979

G3 ♀ 1957

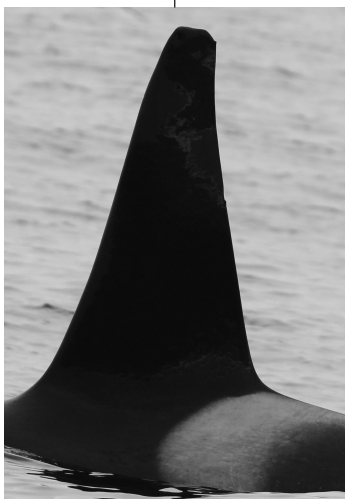
G86 2008



G104 2012

G114 ♀ 2017

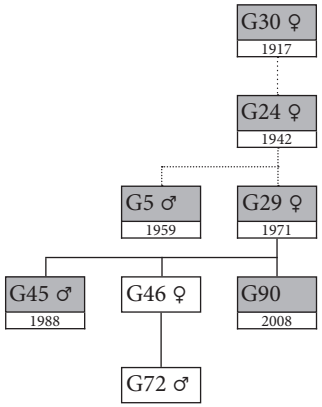
G32 ♂ 1982



G1 Pod,
G46 Matriline

G46 ♀ 1991

G72 ♂ 2005



G1 Pod,
G16 Matriline

G39 ♂ 1986

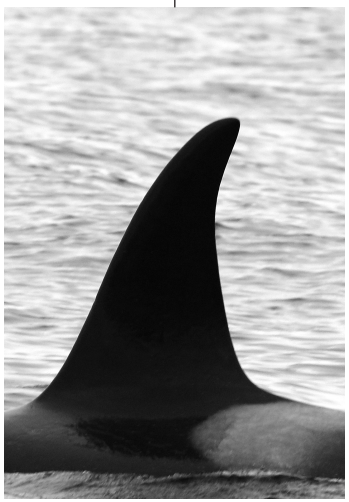
G52 ♀ 1993

G1 Pod,
G31 Matriline

G31 ♀ 1981

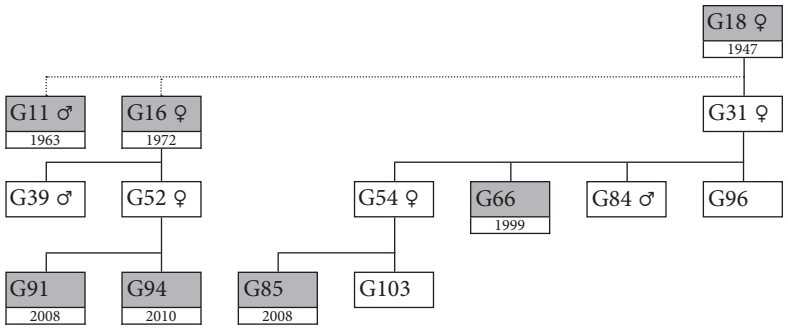
G54 ♀ 1994

G84 ♂ 2007



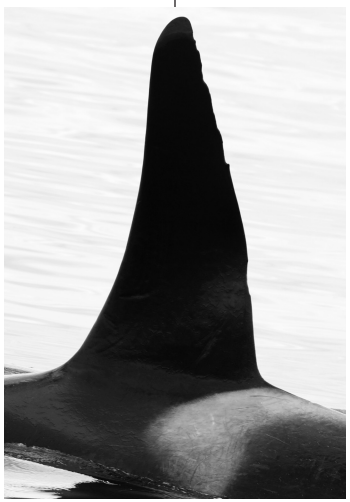
G96 2011

G103 2012



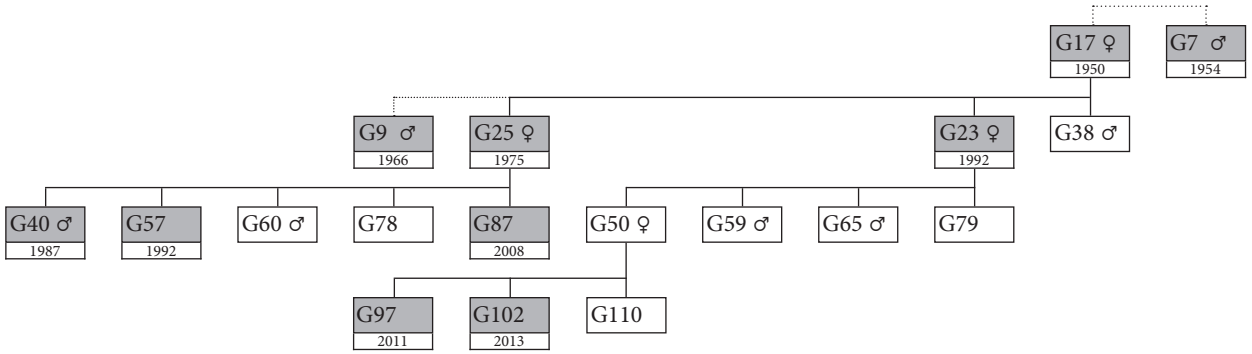
G1 Pod,
G17 Matriline

G60 ♂ 1998



G78 2004

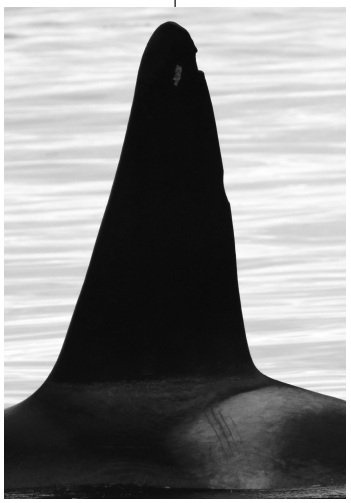
G65 and G38 are often found separate from others in the G17 matriline. Similarly, G60 and G78 normally travel together independent of their other maternal kin.



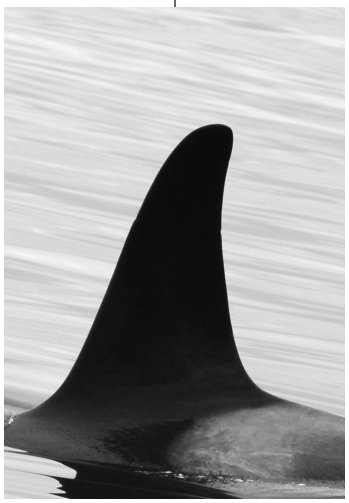
G38 ♂ 1986

G50 ♀ 1991

G59 ♂ 1995



G65 ♂ 2001



G79 2005

G110 2015

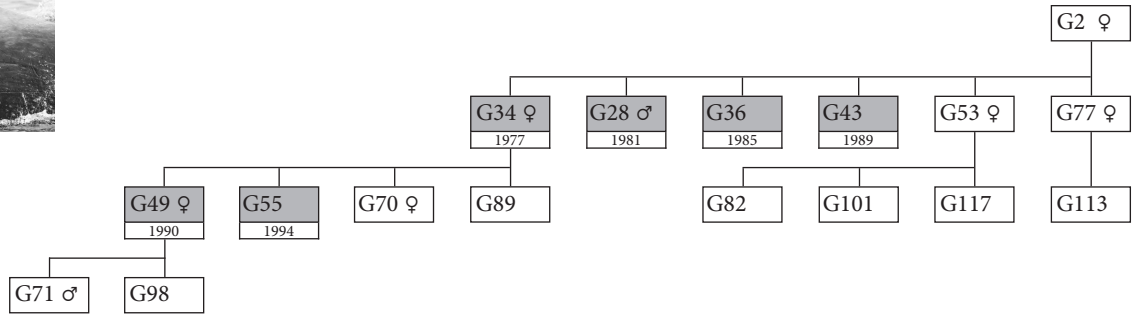
G12 Pod,
G2 Matriline

G70 ♀ 2003

G89 2008

G71 ♂ 2005

G98 2011



Individuals in the G2 matriline are not always found together.

G2 ♀ 1963

G53 ♀ 1994

G77 ♀ 2005

G82 2007

G101 2012

G117 2019

G113 2017

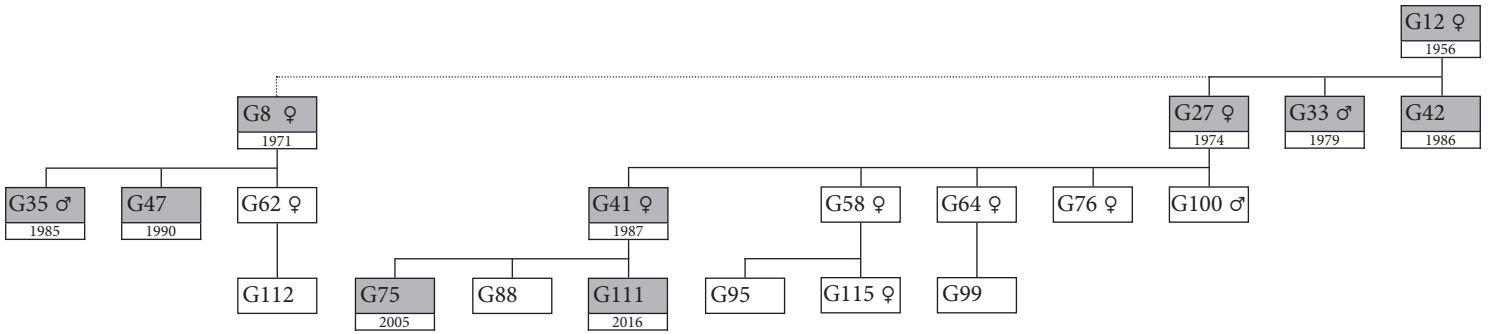
G12 Pod, **G62 Matriline**

G62 ♀ 1999

G112 2017

G12 Pod, **G27 Matriline**

G88 2008



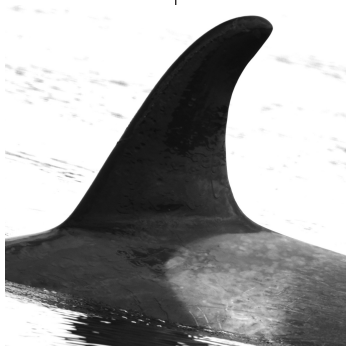
The G27 matriline does not always travel as a cohesive group.

G58 ♀ 1996

G64 ♀ 2000

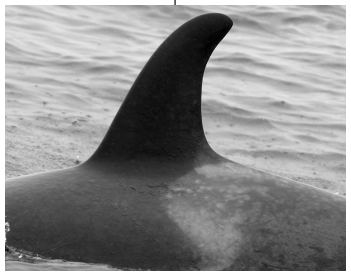
G76 ♀ 2005

G100 ♂ 2012



G95 2011

G115 ♀ 2017



G99 2012

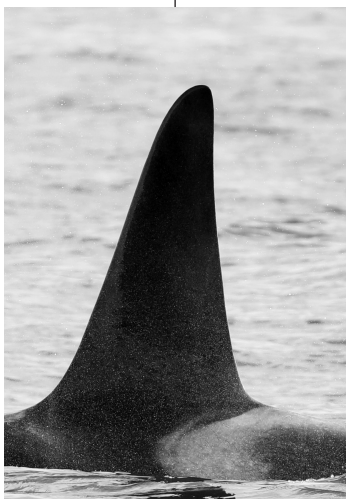
I11 Pod,
I11 Matriline

I12 ♀ 1971

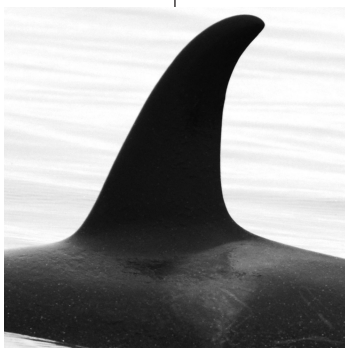
I13 ♀ 1974

I42 ♂ 1983

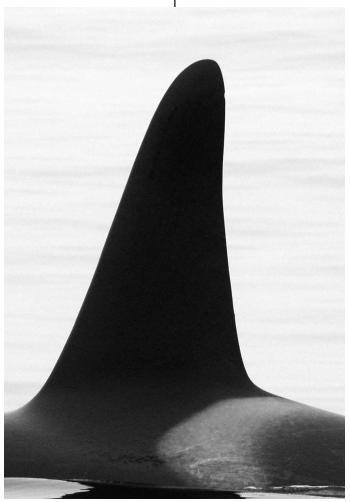
I105 ♂ 2004

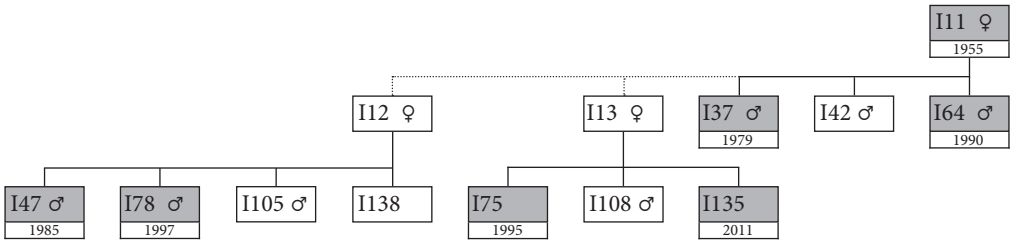


I138 2012



I108 ♂ 2005





I11 Pod,
I16 Matriline

I51 ♀ 1986

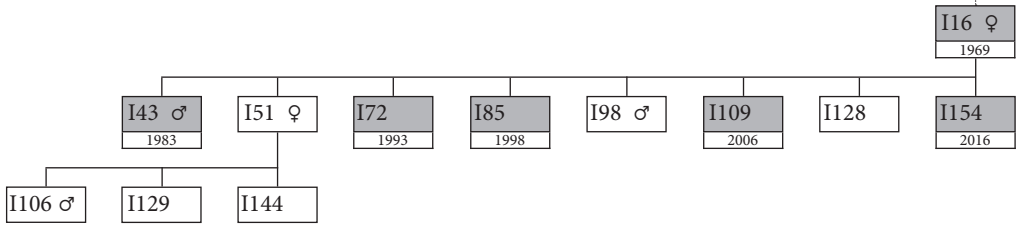
I98 ♂ 2002

I128 2009

I106 ♂ 2004

I129 2009

I144 2014

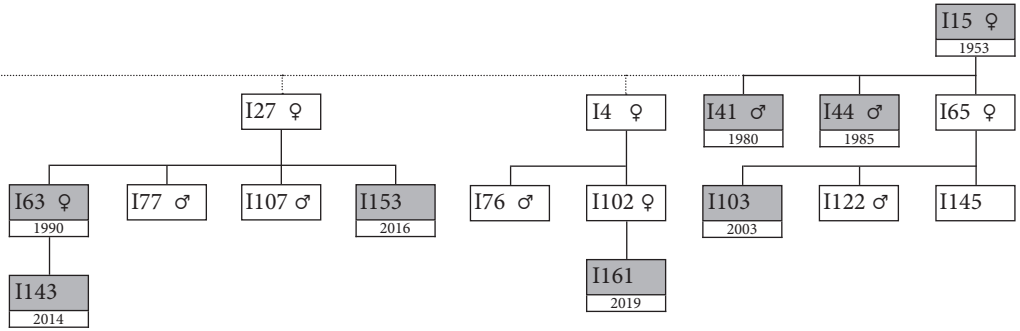


I11 Pod,
I27 Matriline

I27 ♀ 1974

I77 ♂ 1997

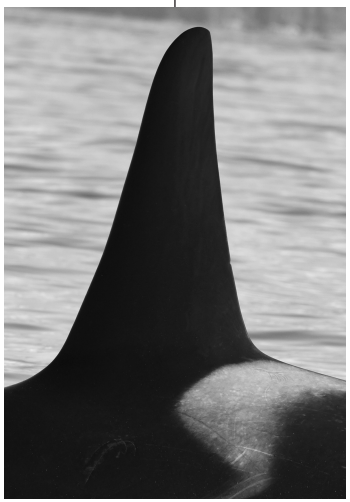
I107 ♂ 2004



I11 Pod,
I4 Matriline

I4 ♀ 1980

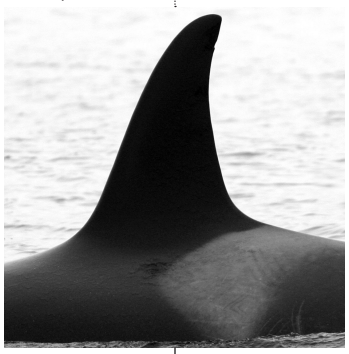
I76 ♂ 1997



I102 ♀ 2003

I11 Pod,
I65 Matriline

I65 ♀ 1990



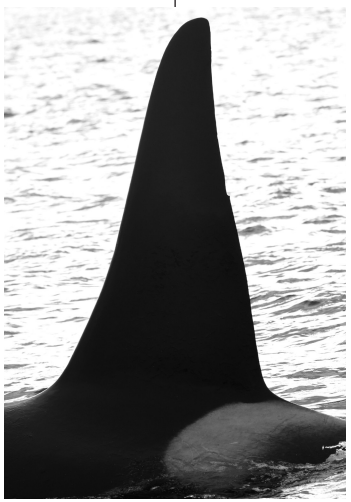
I122 ♂ 2007

I145 2014

I31 Pod,
I33 Matriline

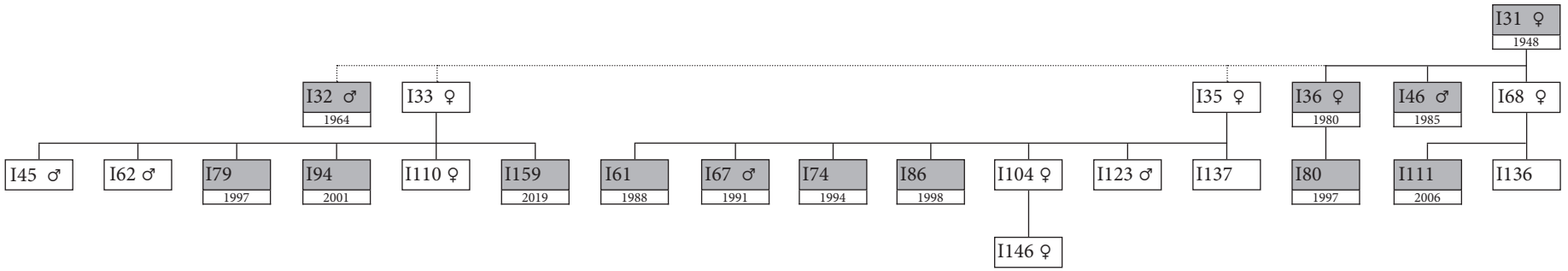
I33 ♀ 1971

I45 ♂ 1985



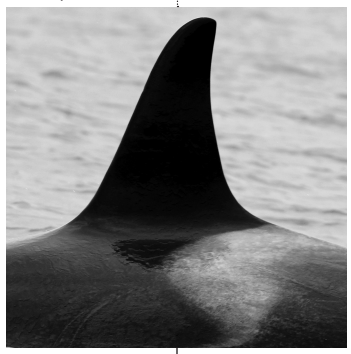
I62 ♂ 1988

I110 ♀ 2006



I31 Pod,
I35 Matriline

I35 ♀ 1974



I104 ♀ 2002

I123 ♂ 2007

I137 2012

I146 ♀ 2014

I31 Pod,
I68 Matriline

I68 ♀ 1991

I136 2012

G-Clan

R1 Pod,
R5 Matriline

R29 ♀ 1994

R48 ♀ 2006

R54 2010

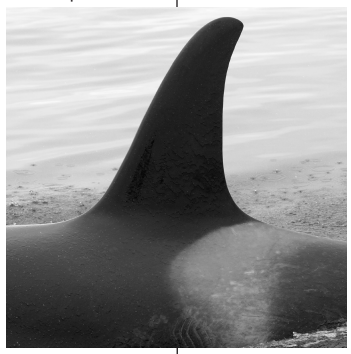
R63 2015

R73 2019

R72 2019

R1 Pod,
R5 Matriline
continued

R35 ♀ 1998



R39 ♀ 2001

R55 2010

R65 2015

R74 2019

R59 2013

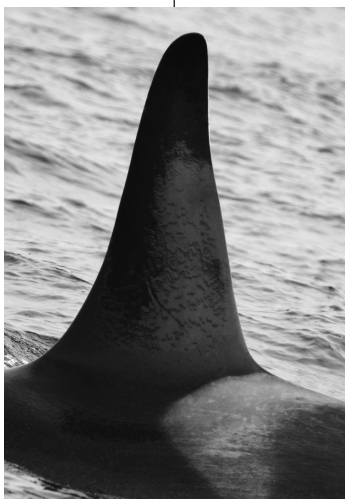
R69 2018

R-Clan

R22 and her progeny are seldom observed in the presence of others in the R4 lineage.

R22 ♀ 1984

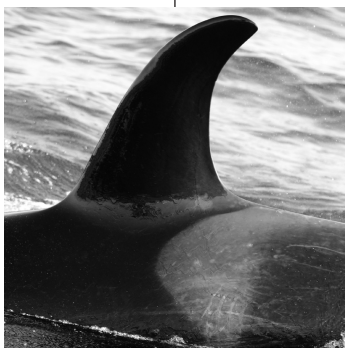
R44 ♂ 2004



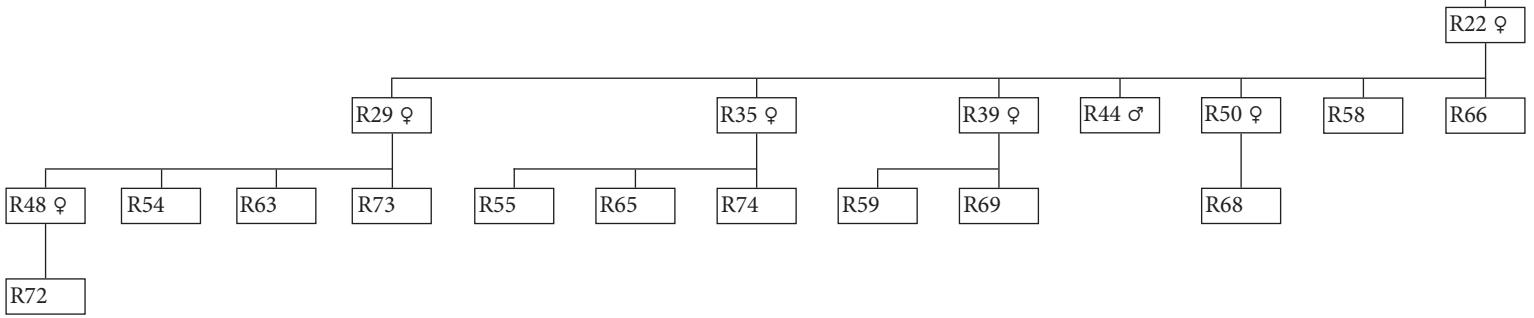
R50 ♀ 2007

R68 2018

R58 2011



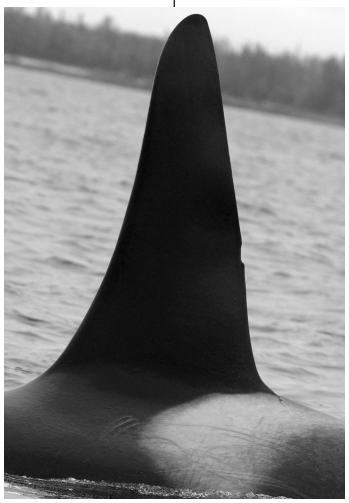
R66 2015



R1 Pod,
R5 Matriline
continued

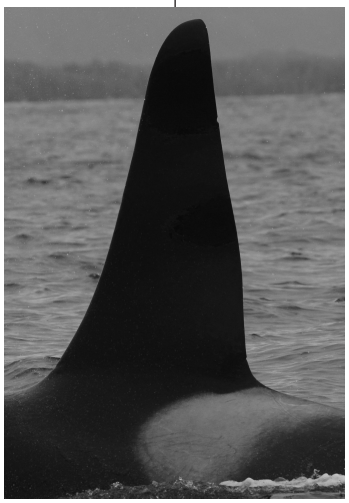
R4 ♀ 1965

R26 ♂ 1988



R33 ♂ 1995

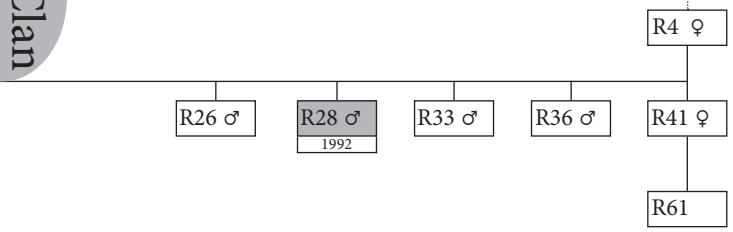
R36 ♂ 1998



R41 ♀ 2002

R61 2014

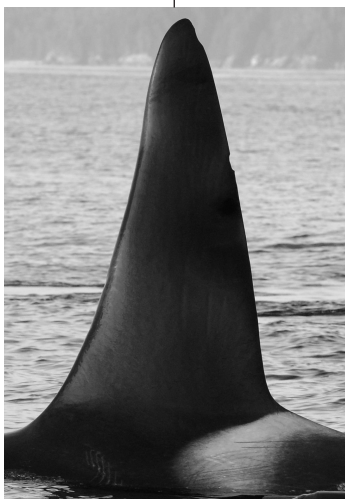
R-Clan



R18 and her offspring are usually found travelling independent of others in the R5 matriline.

R18 ♀ 1968

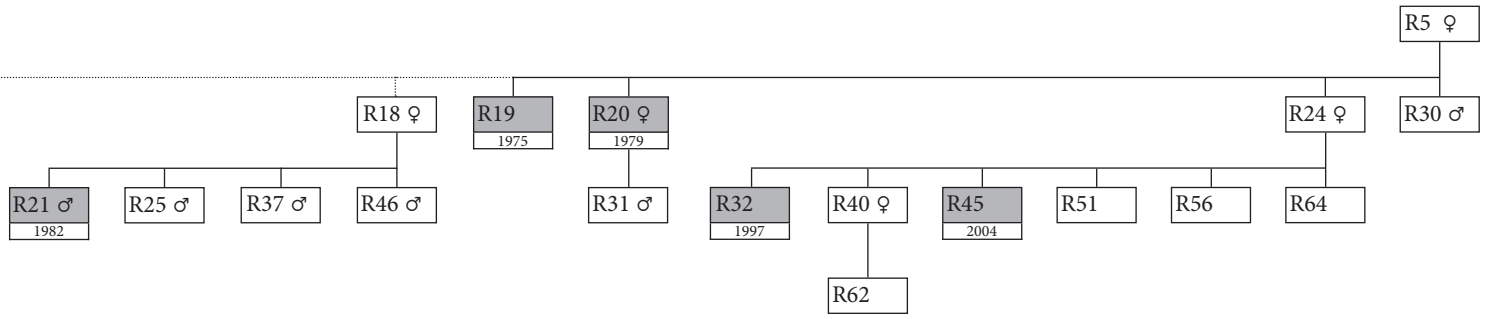
R25 ♂ 1987



R37 ♂ 1999

R46 ♂ 2004

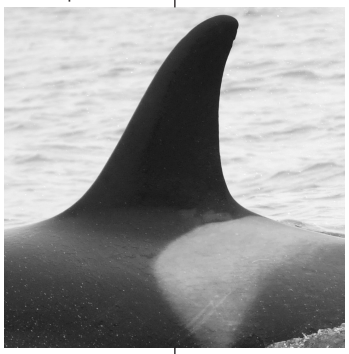
R31 ♂ 1997



R1 Pod,
R5 Matriline
continued

R5 ♀ 1949

R24 ♀ 1987



R30 ♂ 1994

R40 ♀ 2001

R51 2008

R56 2011

R64 2015

R62 2014

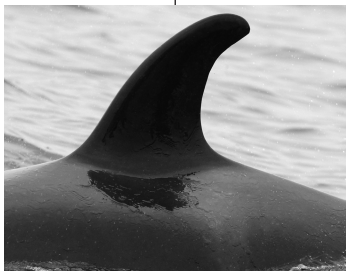
R1 Pod,
R13 Matriline

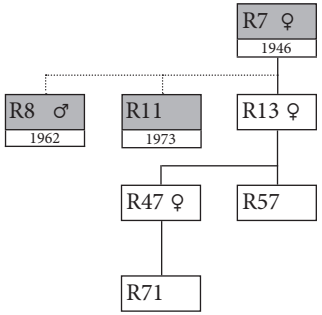
R13 ♀ 1979

R47 ♀ 2005

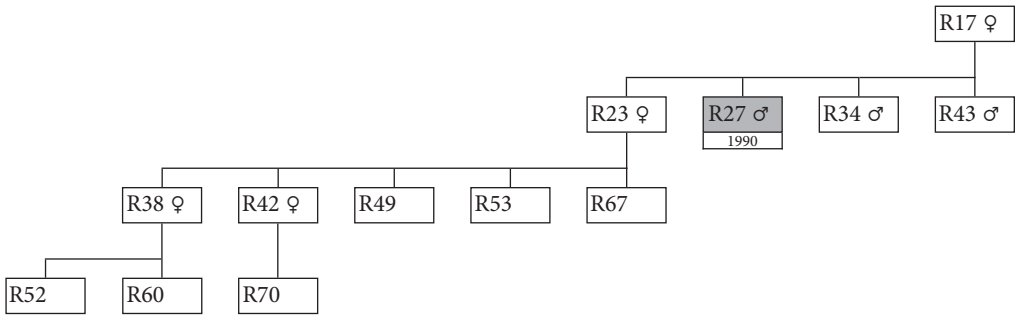
R57 2011

R71 2019





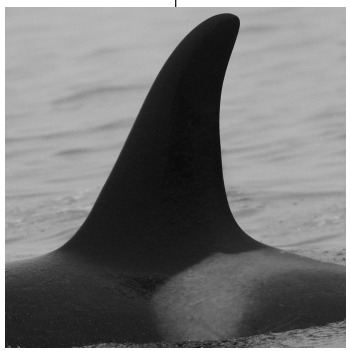
R1 Pod,
R17 Matriline



R38 ♀ 2000

R42 ♀ 2002

R49 2006



R52 2009

R60 2013

R70 2018

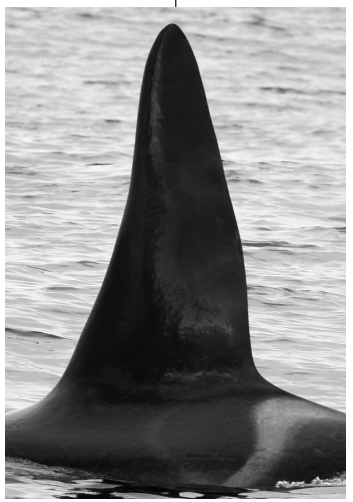
R-Clan

R17 and her male offspring do not always travel with R23 and her progeny.

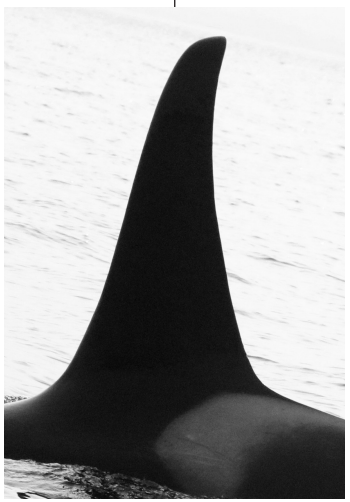
R17 ♀ 1971

R23 ♀ 1985

R34 ♂ 1996



R43 ♂ 2002



R53 2009

R67 2016