PBSdata User's Guide

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1   What is PBSdata?

PBSdata contains data objects used primarily by the R packages PBStools, for illustrating function examples, and PBSmapx, for drawing various coastline and boundary shapefiles. The data herein either exist in the public domain or are non-proprietary and open for public use.

A useful set of data (regional boundaries, key codes, example data), a GUI interface to PBSmapping, and handy utility functions evolved over time (2007–2012) in one R package called PBSfishery, which was hosted on Google's Project site before Google discontinued its SVN repository. In April 2012, we split this package into three separate libraries – PBSdata, PBSmapx, and PBStools – for distribution on GitHub.

2   What is PBS?

The Pacific Biological Station is the oldest fisheries research centre on Canada's Pacific coast and forms part of a network of nine major scientific facilities operated by Fisheries and Oceans Canada. Located in Nanaimo, British Columbia, the Station is home to scientists, technicians, support staff and ships' crews whose common interests are the coastal waters of British Columbia, the Northeast Pacific Ocean, the Western Arctic and navigable waters east to the Manitoba, Saskatchewan border.

PBS was established in 1908 and is the principal centre for fisheries research on Canada's west coast. There are some 22 structures on the site including a four-story office/wet lab building, specialty storage structures for hazardous chemicals and salt water pumping facilities. PBS maintains a number of workshops for research support. There is a wharf used for loading, unloading, and berthage of research vessels, as well as a small boat dock for inshore research boats. Aquatic facilities, primarily used by Aquaculture Science, include ambient temperature and heated salt water and fresh water.

Figure 1. Pacific Biological Station (PBS), Nanaimo BC

Research at PBS responds to stock assessment, aquaculture, marine environment, habitat, ocean science, and fish productivity priorities. Some fisheries management activities are also conducted here.

3 Figure Demos

The `PBSdata` help files provide examples to illustrate the data objects; however, these examples have been disabled using the `dontrun{}` enclosure because we want to keep `PBSdata` from depending on other packages. Many of the examples require `PBSmapping`, and a few will require `PBStools`. In turn, `PBStools` depends on `PBSmapping`, `PBSmodelling`, `PBSdata`, and `RODBC`.

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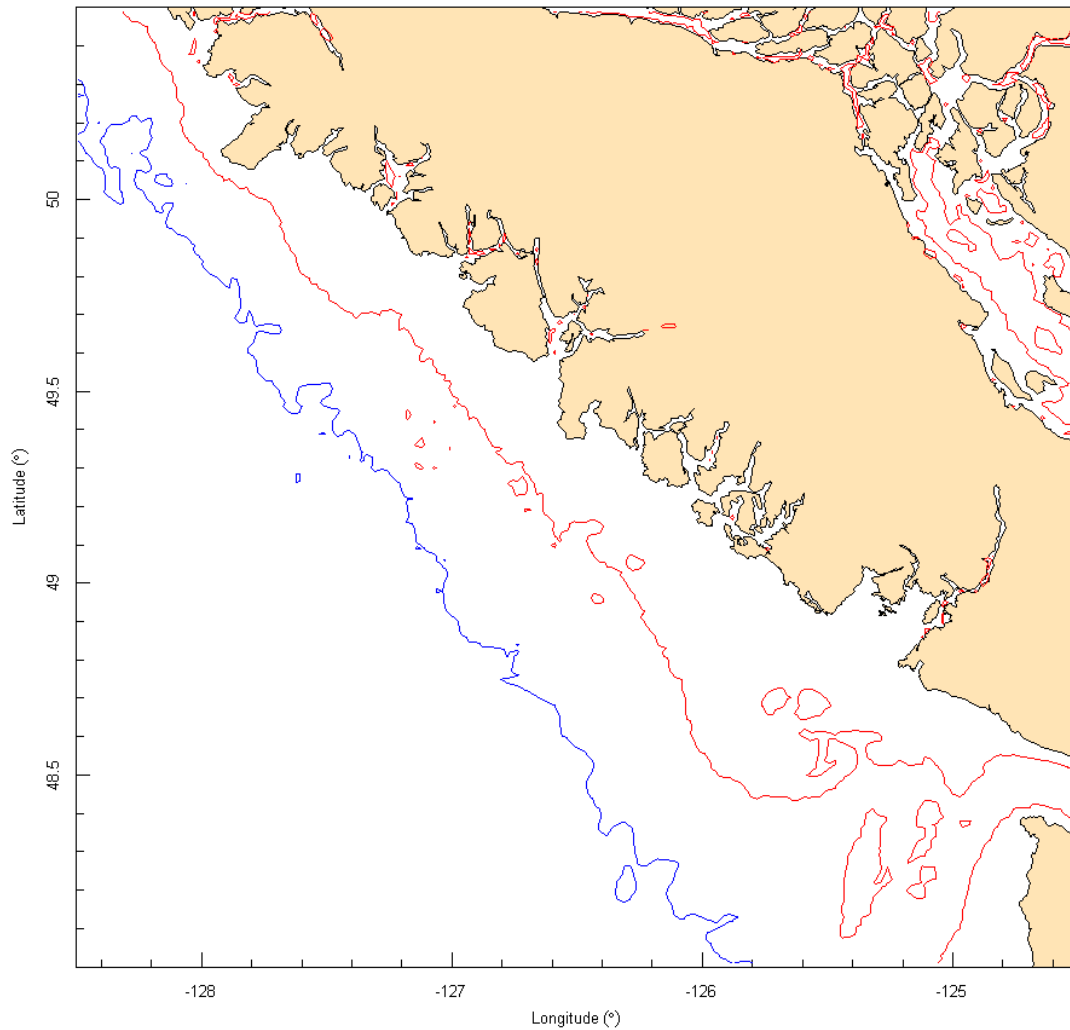
Figure 2. Data frame of sea floor topography (Smith and Sandwell, 1997) downloaded from TOPEX and reformatted for use by `makeTopography` in `PBSmapping`.

Example code for `bctopo`:

```
pbsfun=function(xlim=c(-128.5,-124.5),ylim=c(48,50.5),zlev=c(123,1234)) {
  require(PBSmapping); data(bctopo,nepacLL)
  zx=bctopo$x>=xlim[1] & bctopo$x<=xlim[2] &!is.na(bctopo$x)
  zy=bctopo$y>=ylim[1] & bctopo$y<=ylim[2] &!is.na(bctopo$y)
  topo=bctopo[zx&zy,]
  bathy = makeTopography(topo)
  bCL   = contourLines(bathy,levels=zlev)
  bCP   = convCP(bCL,projection="LL",zone=9)
  bPoly = bCP$PolySet
  plotMap(nepacLL,xlim=xlim,ylim=ylim,col="moccasin")
  addLines(bPoly,col=c("red","blue"))
  invisible() }
pbsfun()
```
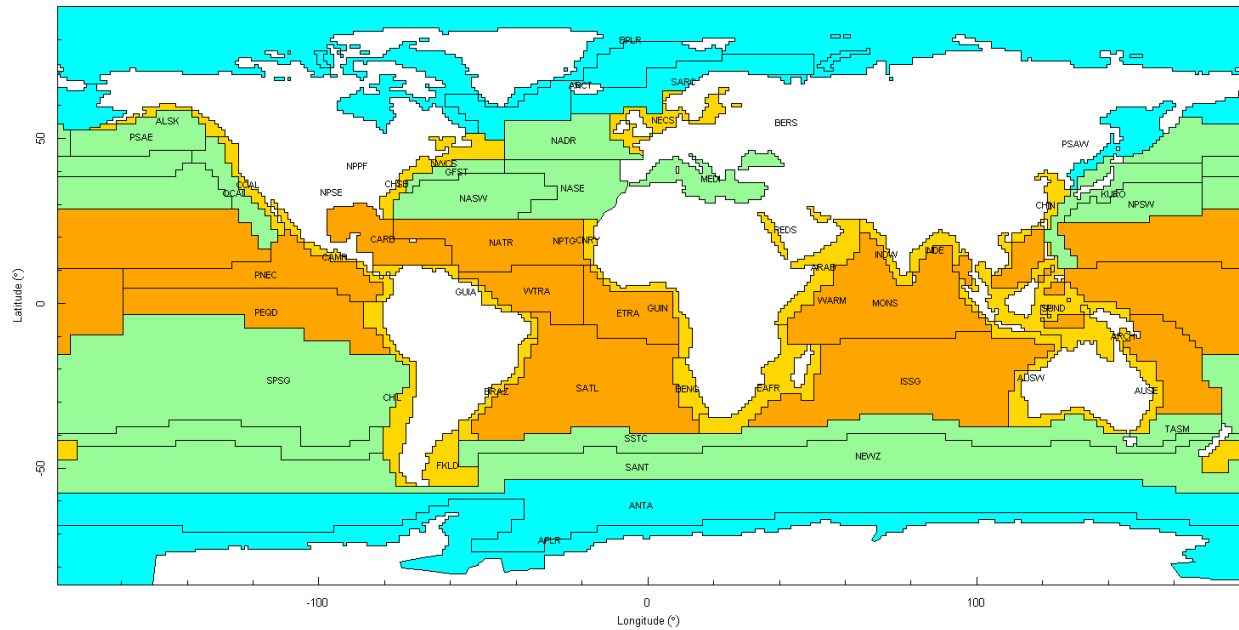
Figure 3. Polygons outlining the biogeochemical provinces of the world's oceans as defined by Dr. Alan Longhurst and others (Longhurst, 2007; Pauly *et al.*, 2000).

Example code for `bgcp`:

```
pbsfun=function(){
  require(PBSmapping); data(bgcp)
  pdata <- attributes(bgcp)$PolyData
  plotMap(bgcp,polyProps=pdata,plt=c(.05,.99,.05,.99))
  pdata$label=pdata$bgcp
  addLabels(pdata,cex=.7) }
pbsfun()
```
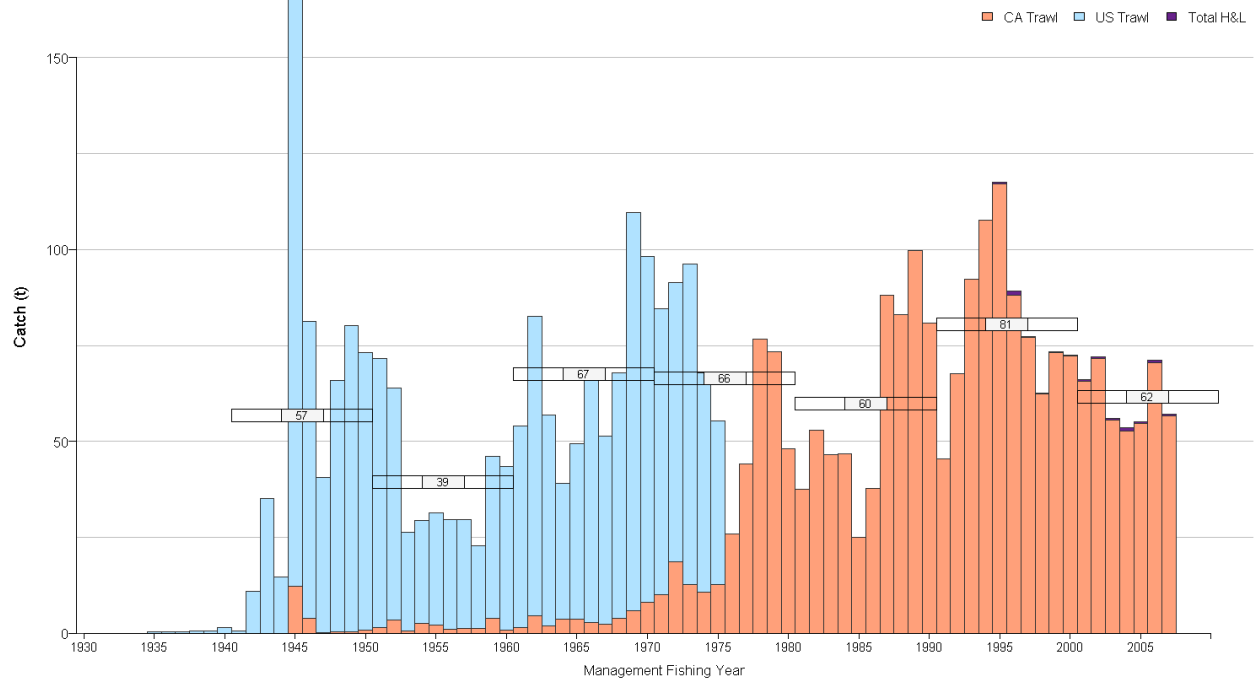
Figure 4. Annual catches of Darkblotched Rockfish *Sebastes crameri* in BC waters by gear sector and nationality (currently, only US Trawl available for non-domestic). See Haigh and Starr (2008b,a) for assessment details.

Example code for `dbrrem`:

```
require(PBStools)
plotCatch(dbr.rem)
```
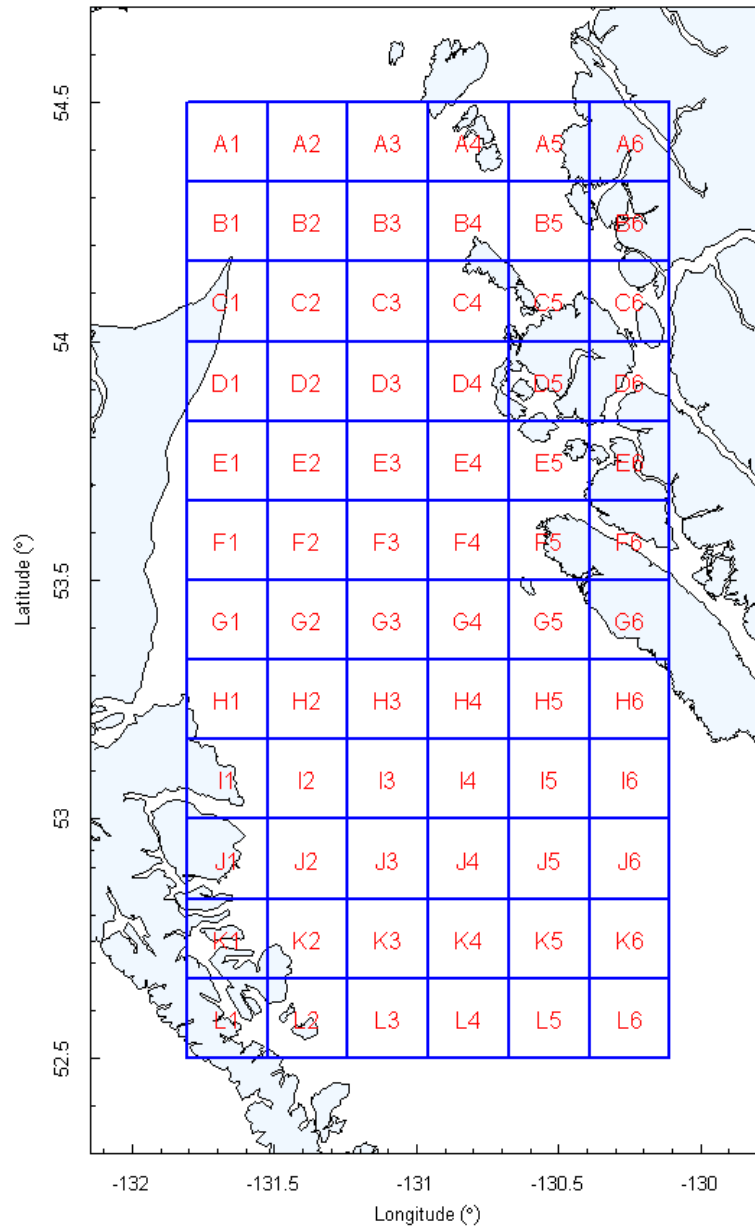
Figure 5. PolySet of polygons for the Hecate Strait Assemblage Survey grid (Fargo and Tyler, 1992).

Example code for `hsgrid`:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL, hsgrid)
  xlim=extendrange(hsgrid$X,f=0.2); ylim=extendrange(hsgrid$Y,f=0.1)
  plotMap(nepacLL,xlim=xlim,ylim=ylim,col="aliceblue")
  addPolys(hsgrid,border="blue",lwd=2)
  addLabels(extractPolyData(hsgrid),placement="CENTROID",
    polys=hsgrid,col="red")
  invisible() }
pbsfun()
```
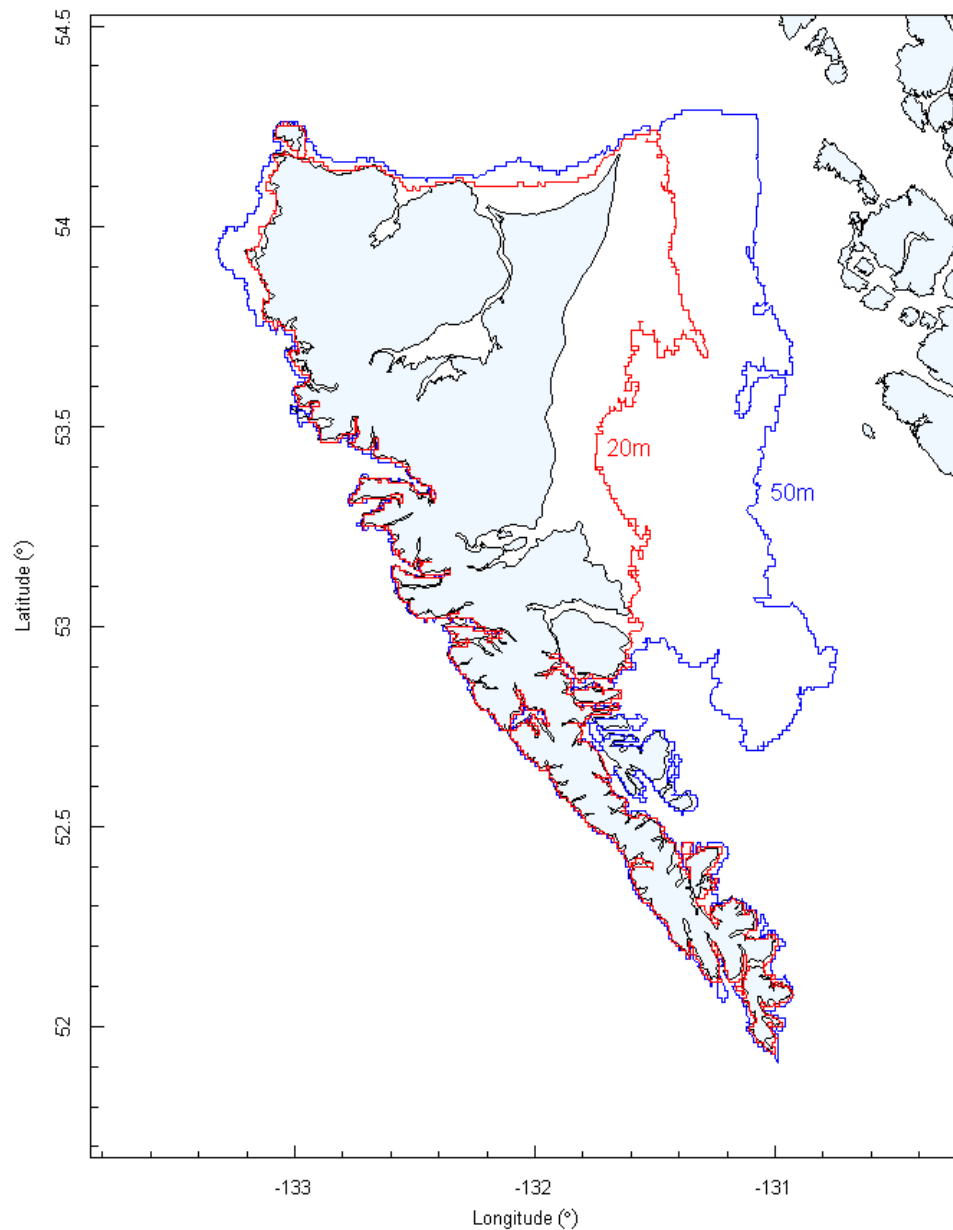
Figure 6. PolySet of polylines that trace the 20m and 50m isobaths in Hecate Strait, British Columbia (BC).

Example code for `hsisob`:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL, hsisob)
  pdata=attributes(hsisob)$PolyData
  xlim=extendrange(hsisob$X,f=0.2); ylim=extendrange(hsisob$Y,f=0.1)
  plotMap(nepacLL,xlim=xlim,ylim=ylim,col="aliceblue")
  addLines(hsisob,col=c("red","blue"),lwd=1)
  addLabels(pdata,adj=0,polyProps=pdata)
  invisible() }
pbsfun()
```
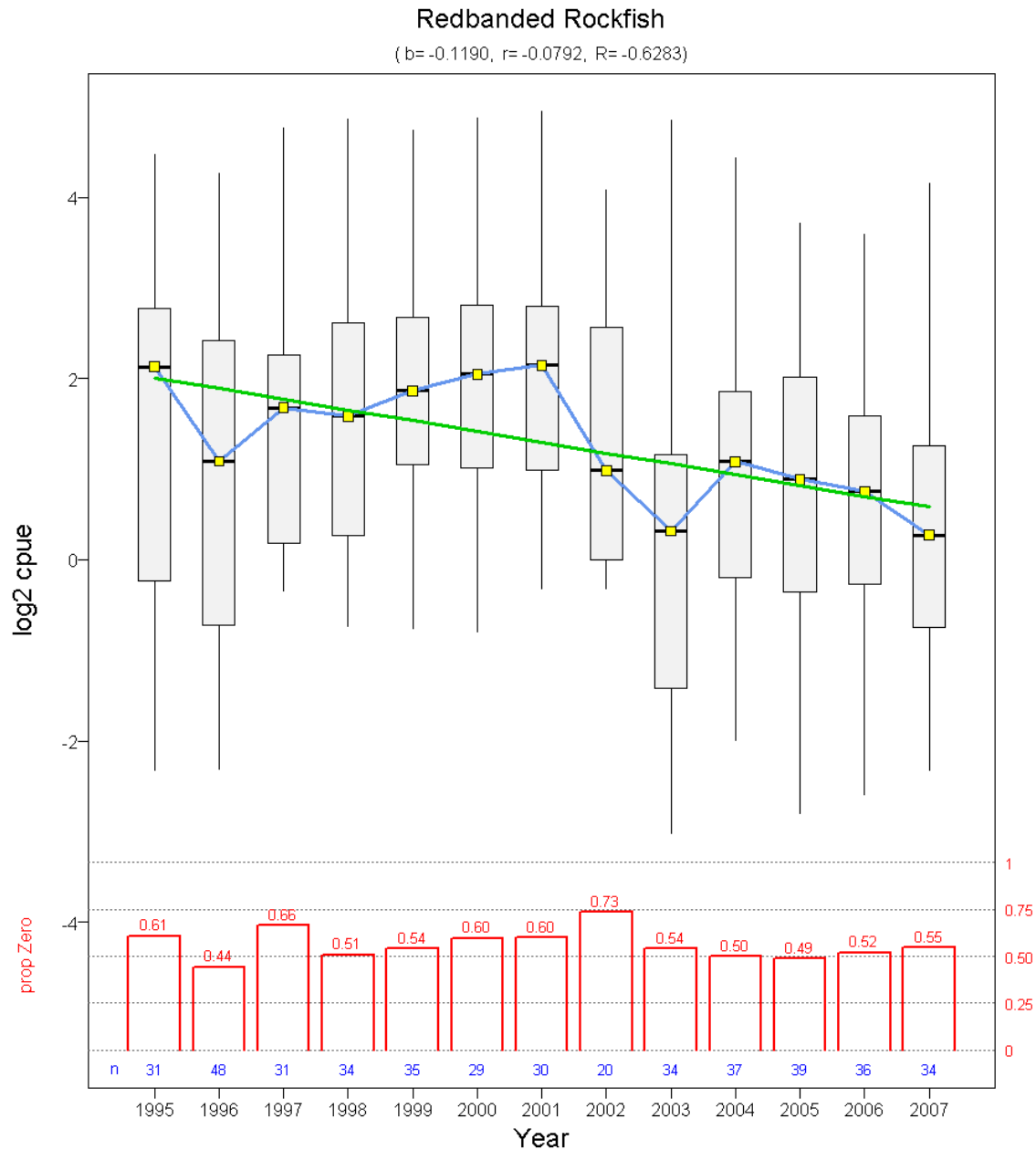
Figure 7. Catch and CPUE indices for the catch of Redbanded Rockfish *Sebastes babcocki* from the International Pacific Halibut Commission's (IPHC) standardized stock assessment (SSA) survey using longline skates (Yamanaka *et al.*, 2008).

Example code for `iphcrbr`:

```
pbsfun=function(){
  require(PBStools); data(iphc.rbr)
  trend("401","iphc.rbr",dbName="none",type="FILE")
  print("Press the GUI button labelled 'TREND'")
  invisible() }
pbsfun()
```
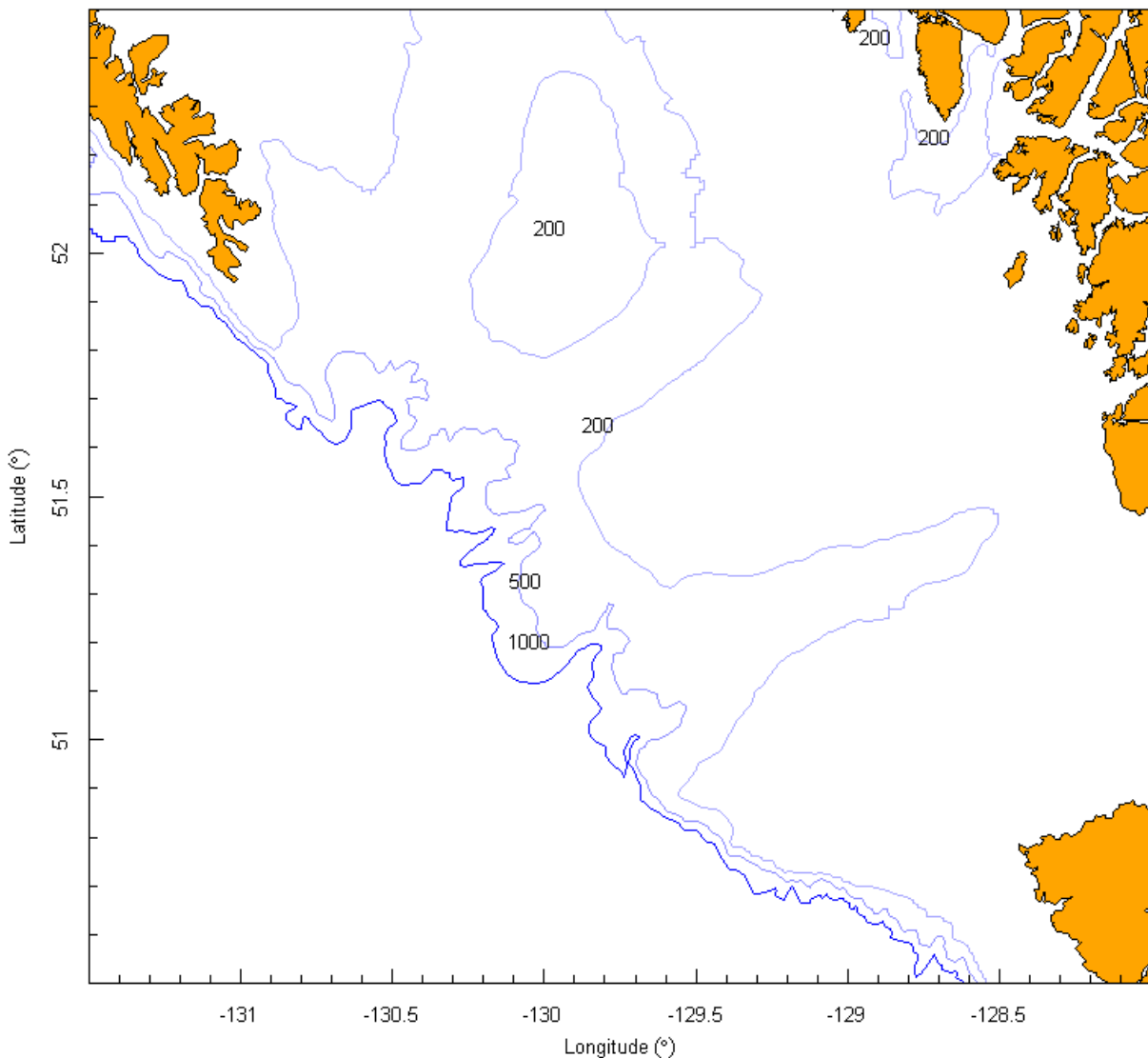
Figure 8. PolySet of polylines describing isobaths from 100m to 1800m at 100m increments. The isobaths are an interpolation from a bathymetry grid created from a triangular irregular network (TIN) that was created from Canadian Hydrographic Service digital natural resource maps (Schnute *et al.*, 1999).

Example code for `isobath`:

```
pbsfun=function(){
  require(PBSmapping); data(isobath,nepacLL)
  xlim = c(-131.5,-128); ylim = c(50.5,52.5)
  ptemp = attributes(isobath)$PolyData
  plotMap(nepacLL,xlim=xlim,ylim=ylim,col="orange")
  itemp = clipLines(isobath[is.element(isobath$PID,c(200,500,1000)),],xlim=xlim,ylim=ylim)
  addLines(itemp,polyProps=ptemp)
  warn=options()$warn; options(warn=-1)
  addLabels(ptemp,polys=itemp,placement="MEAN_XY",cex=.8,adj=1); box()
  options(warn=warn); invisible() } ;    pbsfun()
```
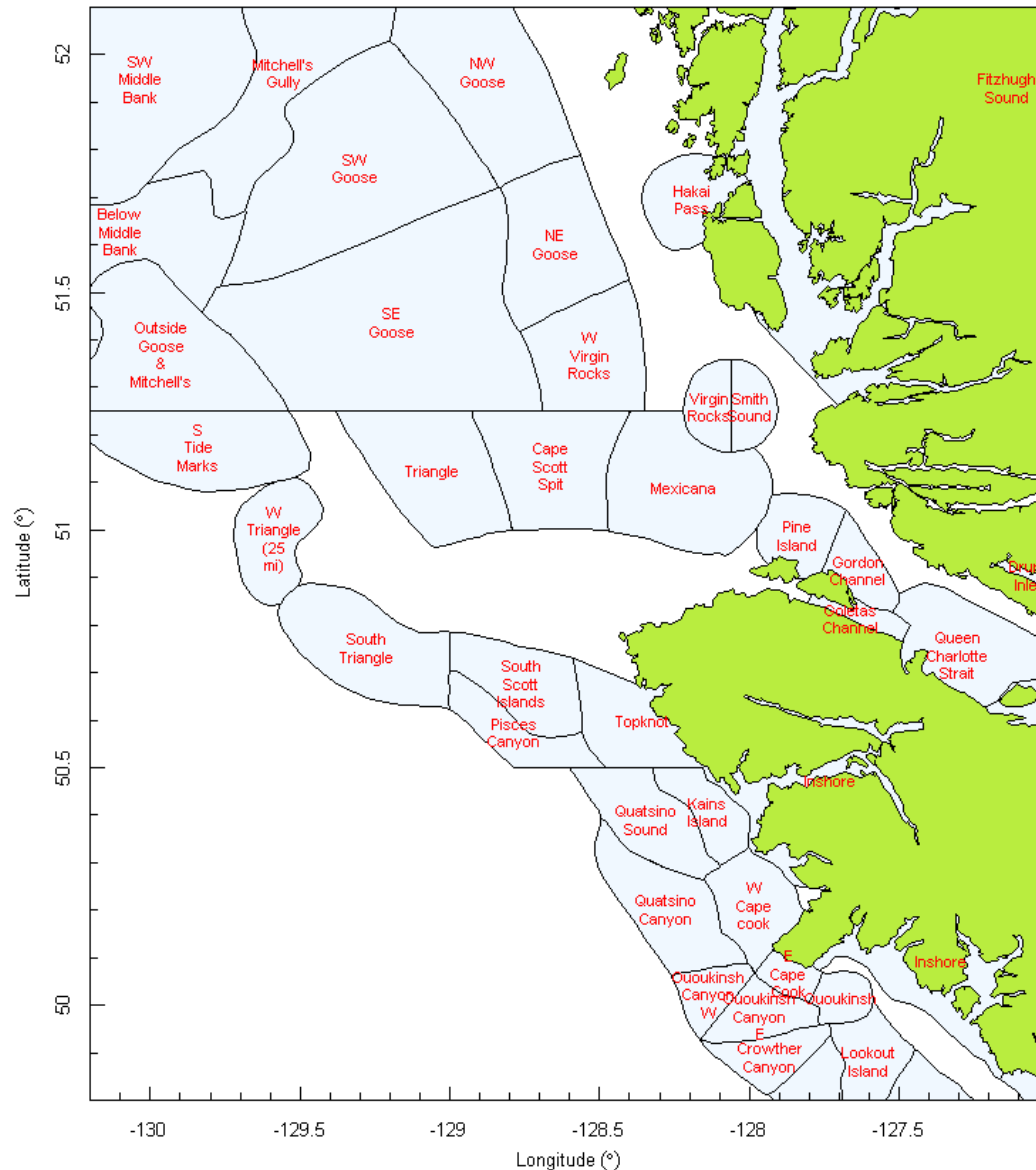
Figure 9. PolySet of polygons for fishing ground localities within Pacific Marine Fisheries Commission (PMFC) minor areas (Schnute *et al.*, 2001; Tagart, 1991).

Example code for `locality`:

```
pbsfun=function(){
  require(PBSmapping);  data(locality,nepacLL)
  plotMap(locality,xlim=c(-130.2,-127),ylim=c(49.8,52.1),col="aliceblue")
  addPolys(nepacLL,col="#b9ed3f")
  pdata <- attributes(locality)$PolyData
  pdata$label <- gsub("[/-]"," ",pdata$name)
  pdata$label=sapply(sapply(pdata$label,strsplit,split=" "),paste,collapse="\n")
  addLabels(pdata,polys=locality,placement="CENTROID",cex=.65,col="red")
  invisible() }
pbsfun()
```
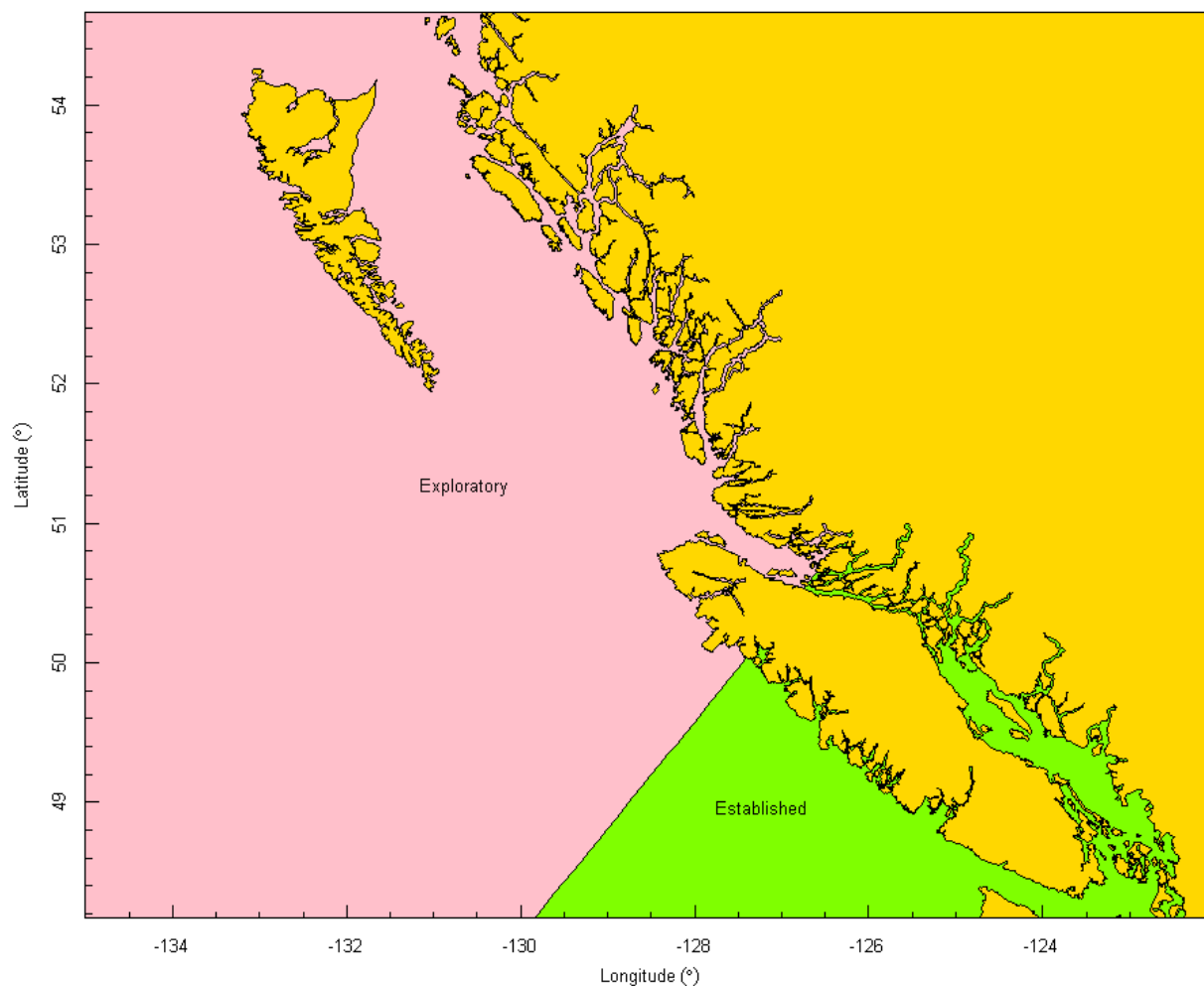
Figure 10. PolySet of polygons describing management areas for Longspine Thornyhead
Sebastolobus altivelis during the 2000 and 2001 fishing years (April 1 to March 31).
See Schnute *et al.* (2004) for details.

Example code for `ltea`:

```
pbsfun=function(){
  require(PBSmapping)
  data(ltea,nepacLL)
  plotMap(ltea,xlim=range(ltea$X),ylim=range(ltea$Y),col=c("chartreuse","pink"))
  addPolys(nepacLL,col="gold")
  text(c(-127.23,-130.64), c(48.97,51.27),c("Established","Exploratory"),cex=.8)
  invisible() }
pbsfun()
```
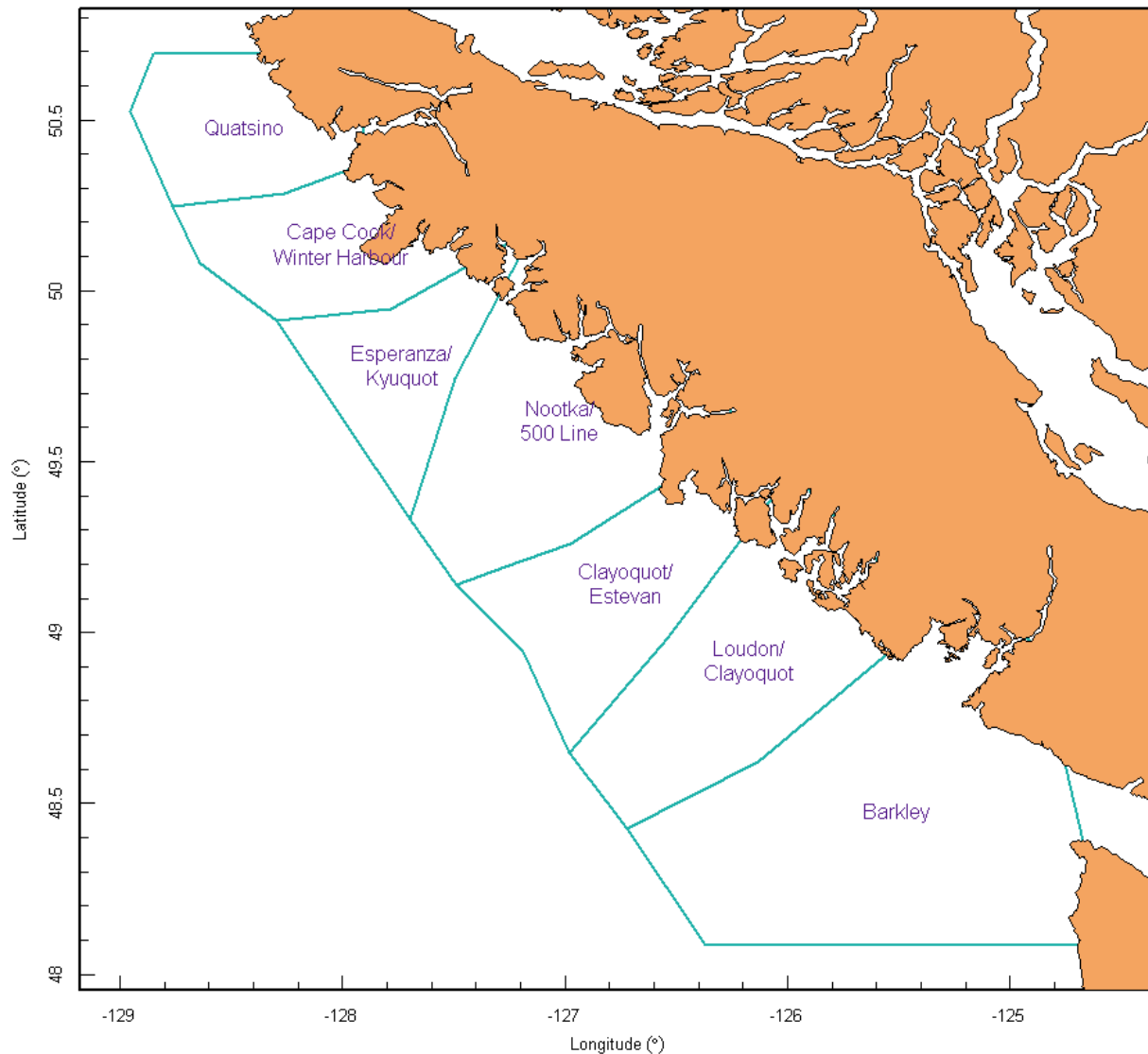
Figure 11. PolySet of polygons describing 7 Longspine Thornyhead fishing grounds off the west coast of Vancouver Island (WCVI) according to Brian Mose of the Canadian Groundfish Research and Conservation Society (CGRCS). See Krishka *et al.* (2005); Starr *et al.* (2002b,a) for details of the Thornyhead surveys.

Example code for `ltmose07`:

```
pbsfun=function(){
  require(PBSmapping)
  data(ltmose07,nepacLL)
  xlim=extendrange(ltmose07$X); ylim=extendrange(ltmose07$Y)
  plotMap(ltmose07,xlim=xlim,ylim=ylim,border="lightseagreen",lwd=2)
  addPolys(nepacLL,col="sandybrown")
  addLabels(attributes(ltmose07)$PolyData,polys=ltmose07,
    placement="CENTROID",col="purple4")
  invisible() }
pbsfun()
```
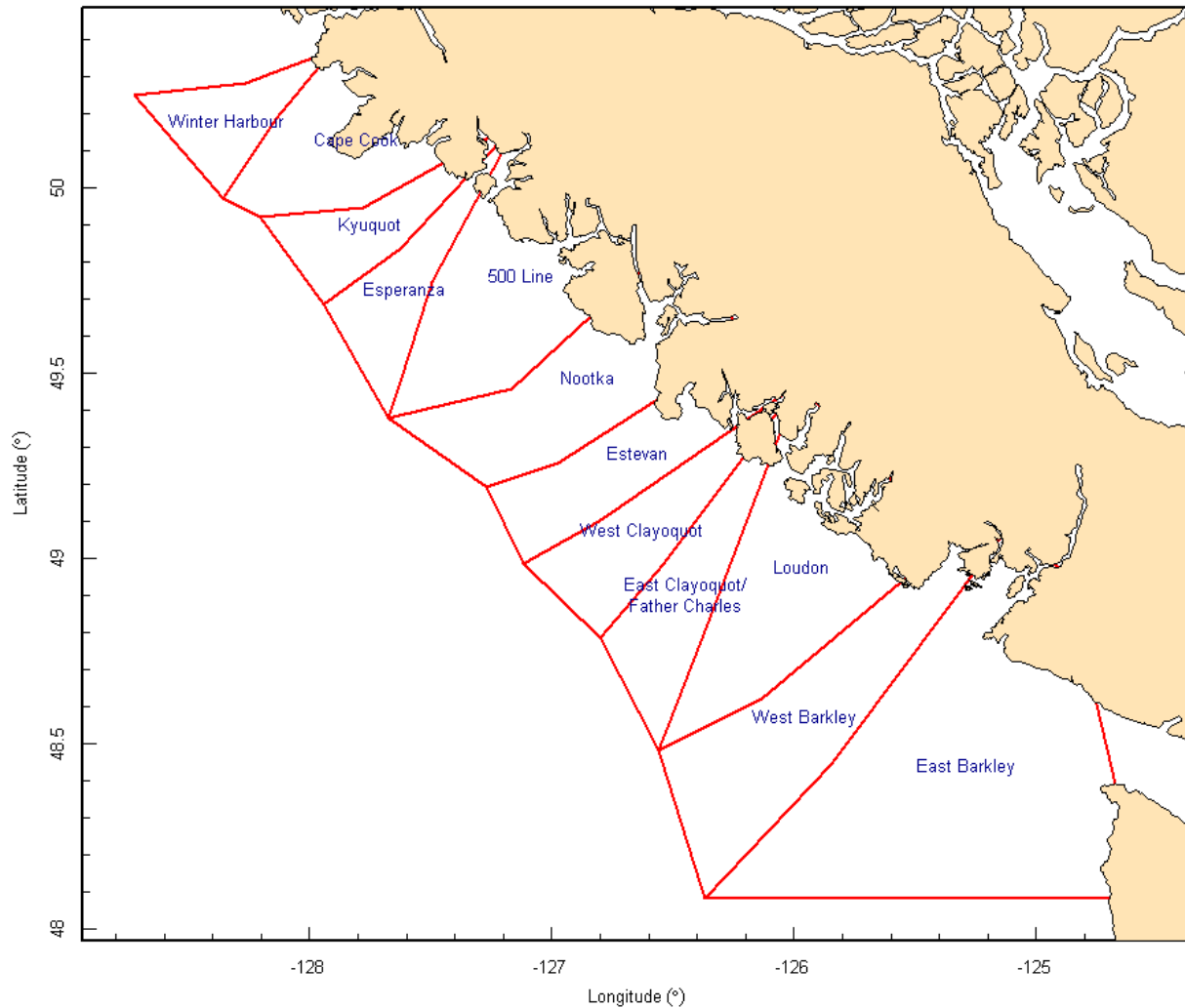
Figure 12. PolySet of polygons describing 12 Longspine Thornyhead fishing grounds off the west coast of Vancouver Island (WCVI) according to Brian Mose of the Canadian Groundfish Research and Conservation Society (CGRCS). See Krishka *et al.* (2005); Starr *et al.* (2002b,a) for details of the Thornyhead surveys.

Example code for `ltmose12`:

```
pbsfun=function(){
  require(PBSmapping)
  data(ltmose12,nepacLL)
  xlim=extendrange(ltmose12$X); ylim=extendrange(ltmose12$Y)
  plotMap(ltmose12,xlim=xlim,ylim=ylim,border="red",lwd=2)
  addPolys(nepacLL,col="moccasin")
  addLabels(attributes(ltmose12)$PolyData,polys=ltmose12,
    placement="CENTROID",col="darkblue",cex=.8)
  invisible() }
pbsfun()
```
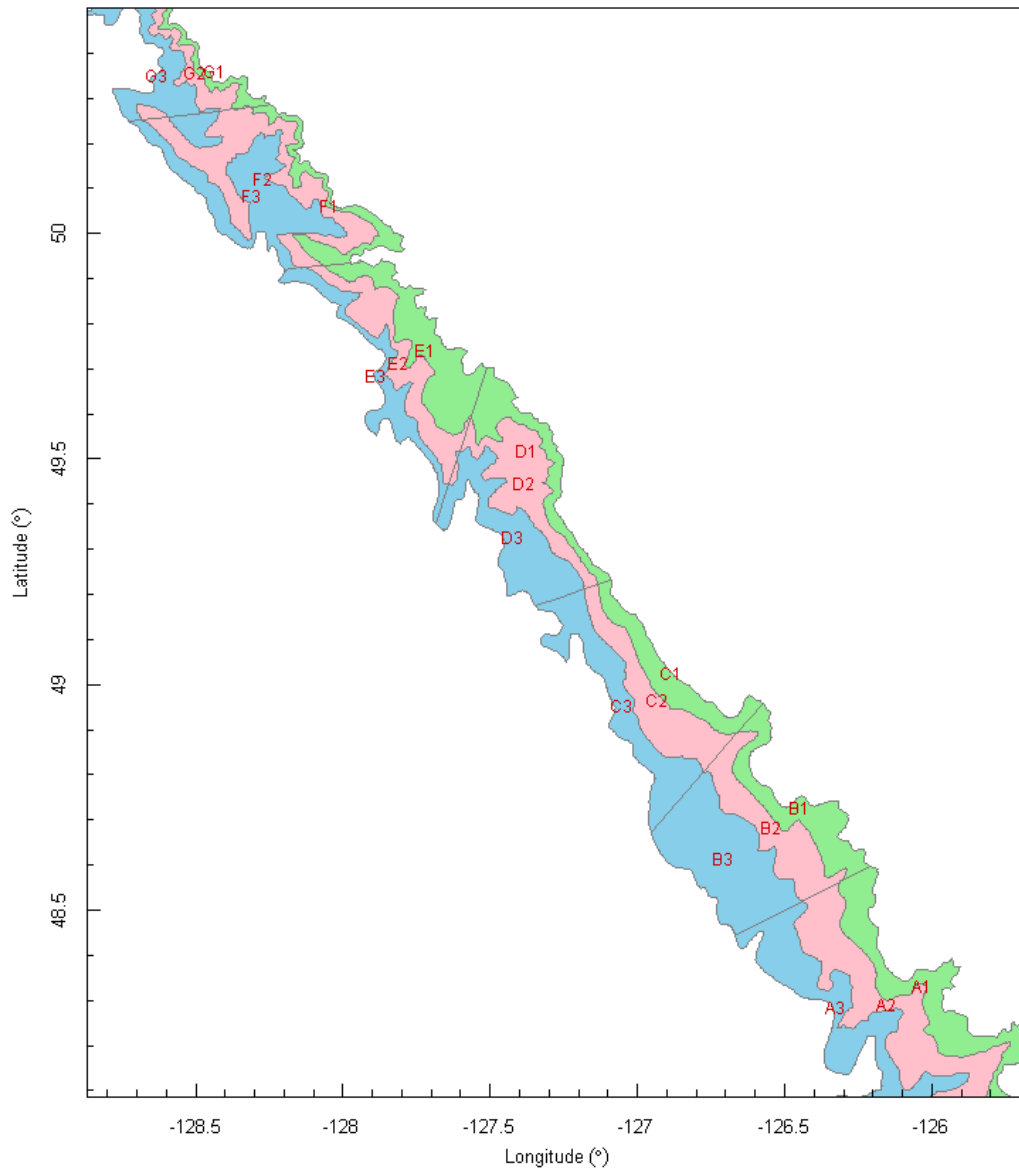
Figure 13. PolySet of polygons describing the survey strata for Longspine Thornyheads off the west coast of Vancouver Island (WCVI). See Krishka *et al.* (2005); Starr *et al.* (2002b,a) for details of the Thornyhead surveys, and Schnute *et al.* (2004) for analysis of the survey results.

Example code for `ltsa`:

```
pbsfun=function(){
  require(PBSmapping); data(ltsa)
  plotMap(ltsa,border="grey50",col=c("lightgreen","pink","skyblue"))
  pdata <- attributes(ltsa)$PolyData
  addLabels(pdata,polys=ltsa,placement="CENTROID",cex=.75,col="red3")
  invisible() }
pbsfun()
```
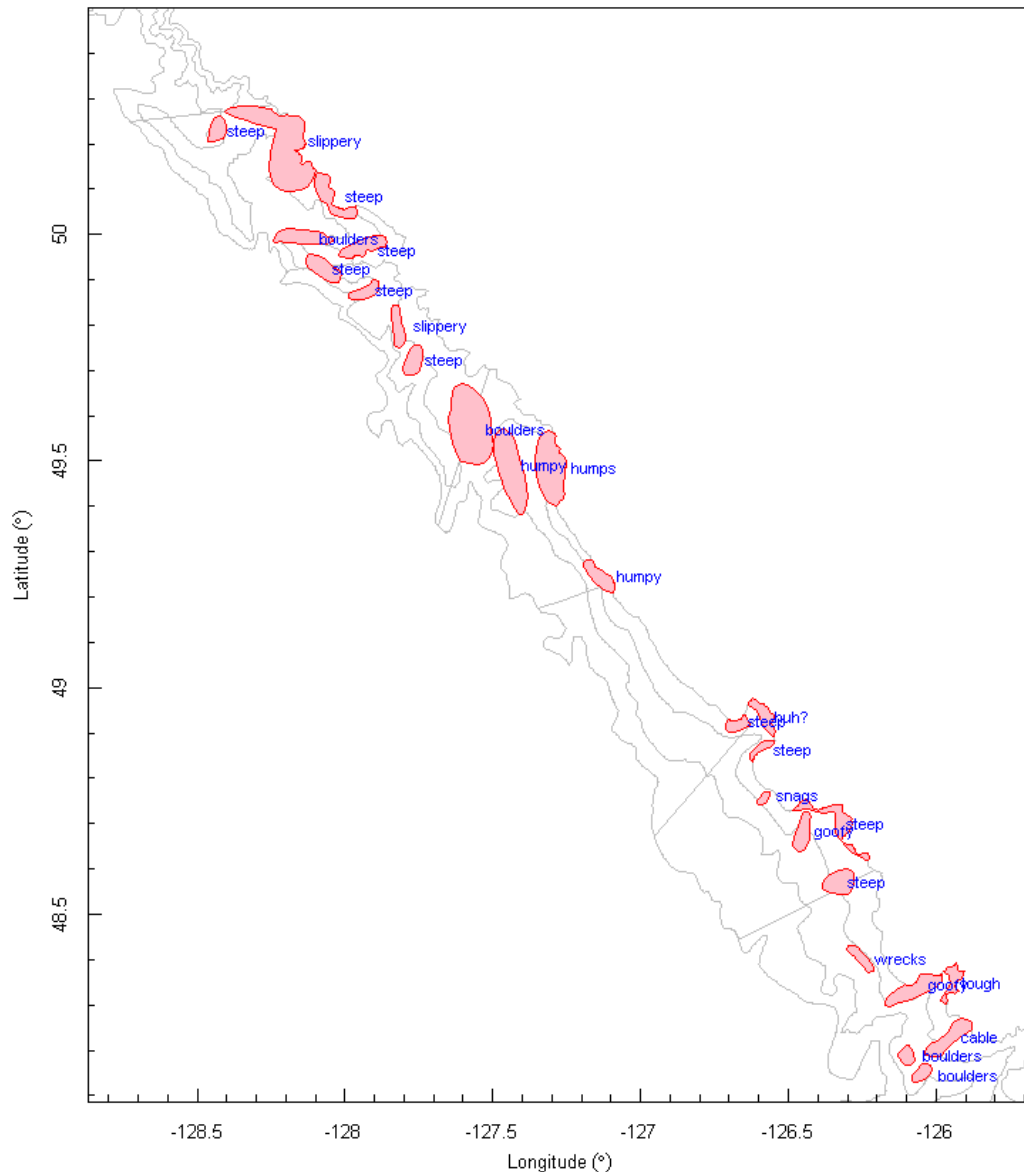
Figure 14. PolySet of polygons describing 26 no-trawl zones in the Longspine Thornyhead survey strata off the west coast of Vancouver Island (WCVI), according to Chris Roberts (CGRCS). See Krishka *et al.* (2005); Starr *et al.* (2002b,a) for details of the Thornyhead surveys, and Schnute *et al.* (2004) for analysis of the survey results.

Example code for `ltsabad`:

```
pbsfun=function(){
  require(PBSmapping); data(ltsa,ltsa.bad)
  plotMap(ltsa,border="grey")
  addPolys(ltsa.bad,col="pink",border="red");
  addLabels(attributes(ltsa.bad)$PolyData,polys=ltsa.bad,placement="MEAN_XY",
    col="blue",cex=0.7,adj=-.3)
  invisible() }
pbsfun()
```
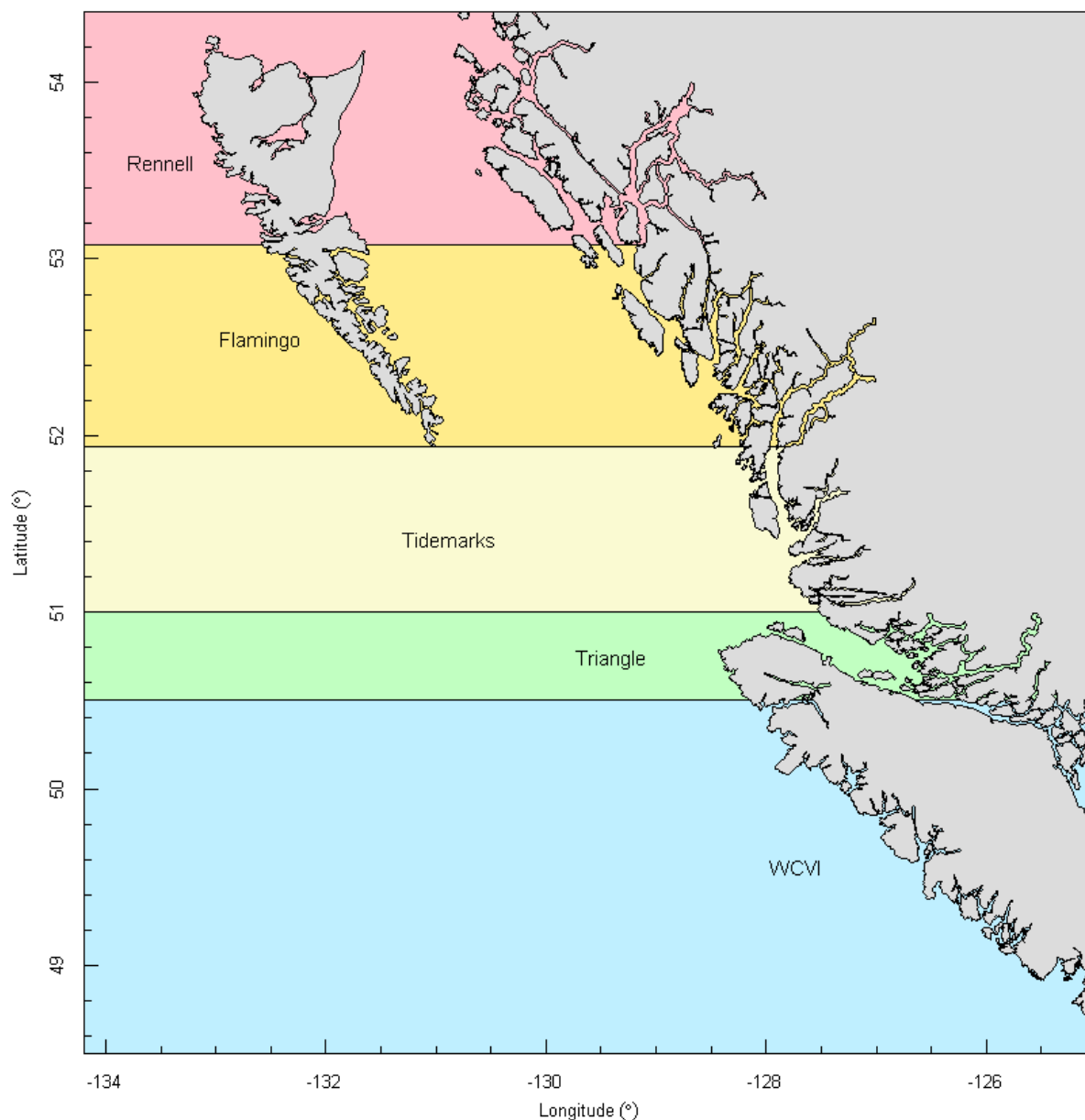
Figure 15. PolySet of polygons describing management areas for Longspine Thornyheads in effect since the 2002 fishing year. See Schnute *et al.* (2004) for analysis of this fishery.

Example code for `ltxa`:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL, ltxa)
  xlim=c(-134.2,-125); ylim=c(48.5,54.40)
  pdata=attributes(ltxa)$PolyData
  plotMap(ltxa,xlim=xlim,ylim=ylim,polyProps=pdata)
  addPolys(nepacLL,col="gainsboro")
  addLabels(pdata,cex=.9)
  invisible() }
pbsfun()
```
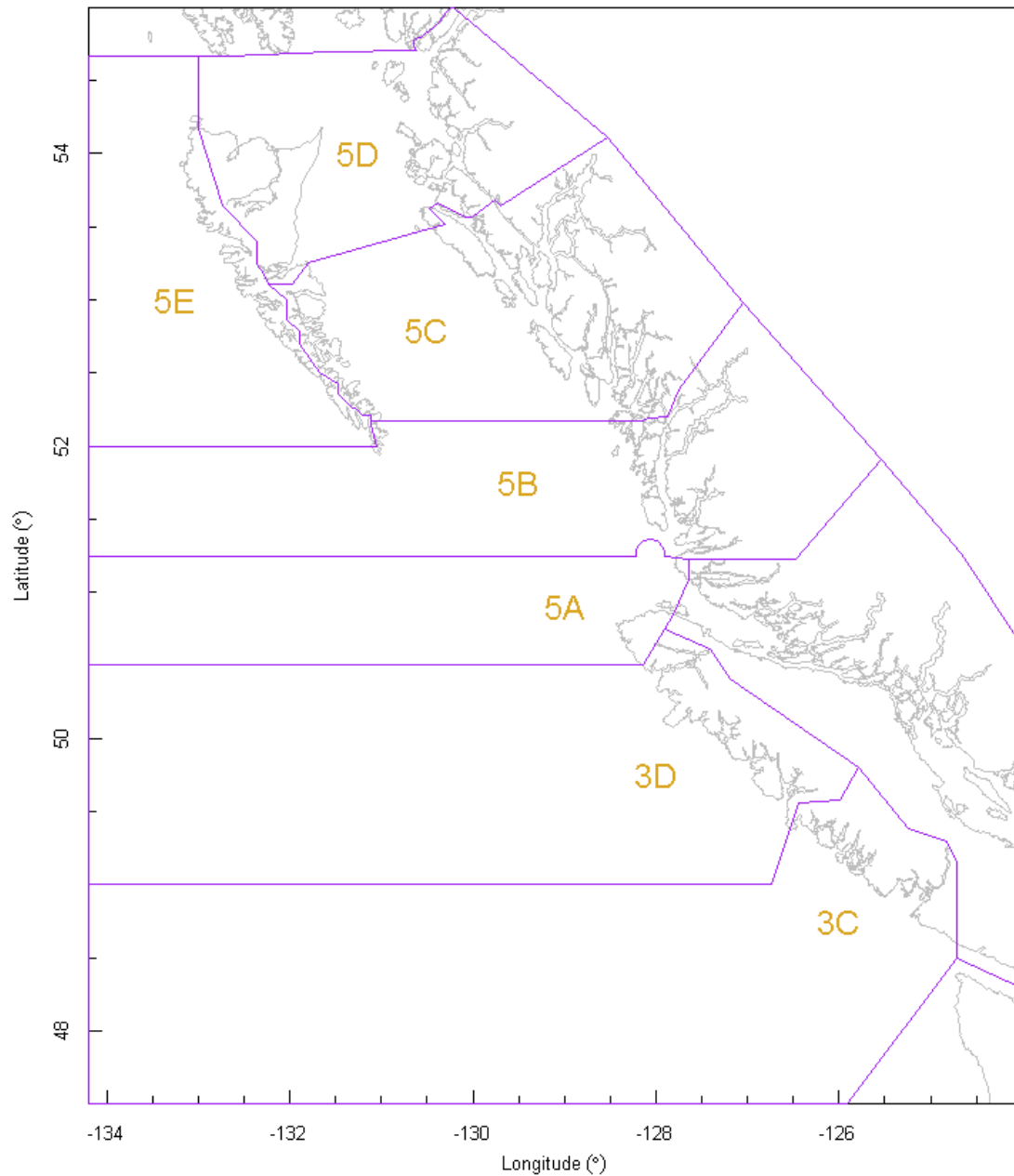
Figure 16. PolySet of polygons for BC's Pacific Marine Fisheries Commission (PMFC) major
    areas. See Schnute *et al.* (2001) and Tagart (1991) for discussions on boundaries.

Example code for `major`:

```
pbsfun=function(){
  require(PBSmapping); data(major,nepacLL)
  plotMap(nepacLL,xlim=c(-134.2,-124),ylim=c(47.5,55),border="grey")
  addPolys(major,border="purple")
  addLabels(attributes(major)$PolyData,col="goldenrod",cex=1.5)
  invisible() }
pbsfun()
```
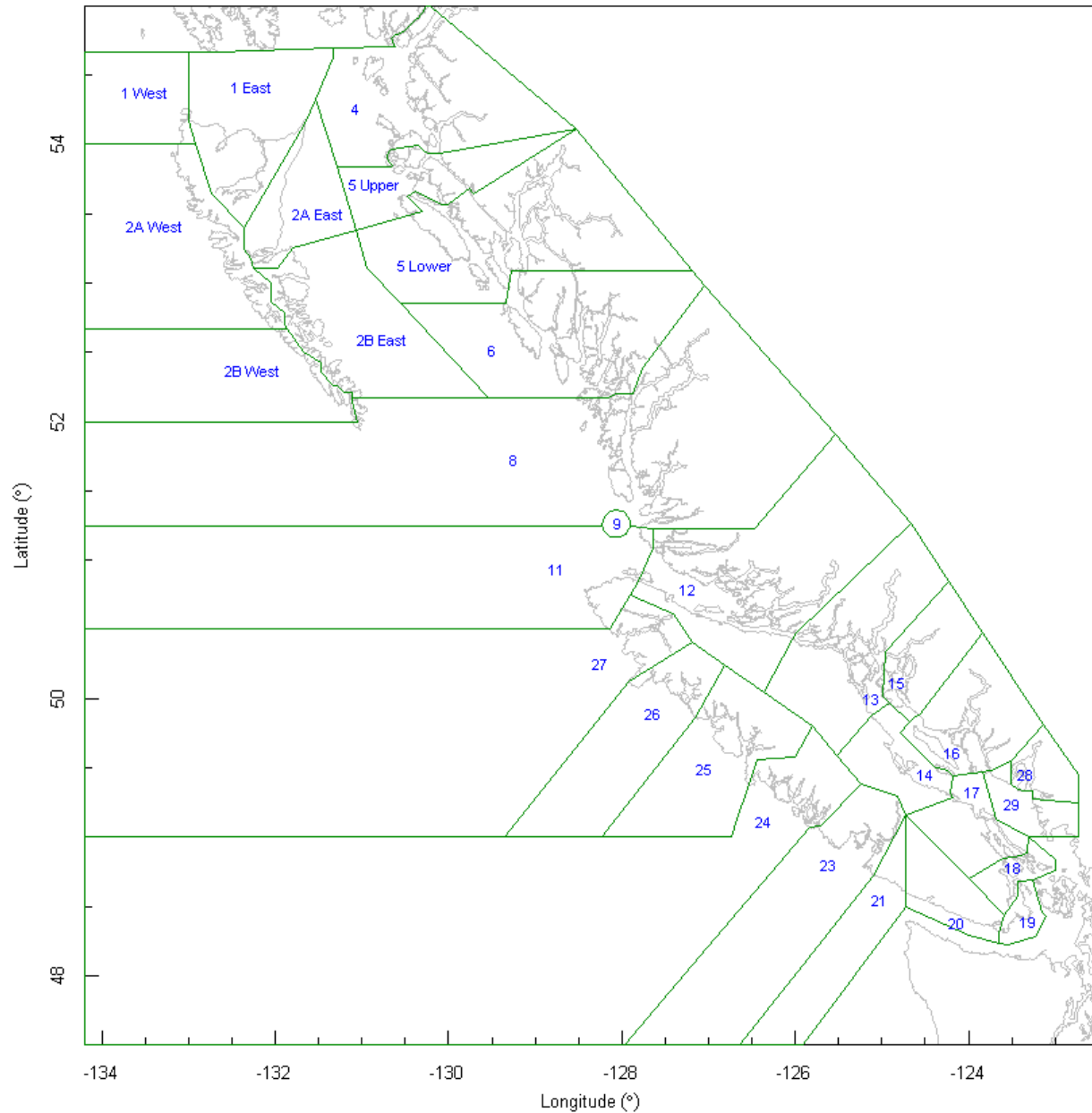
Figure 17. PolySet of polygons for BC's Pacific Marine Fisheries Commission (PMFC) minor areas. See Schnute *et al.* (2001) and Tagart (1991) for discussions on boundaries.

Example code for `minor`:

```
pbsfun=function(){
  require(PBSmapping); data(minor,nepacLL)
  plotMap(nepacLL,xlim=c(-134.2,-122.5),ylim=c(47.5,55),border="grey")
  addPolys(minor,border="green4")
  addLabels(attributes(minor)$PolyData,cex=.7,col=4)
  invisible() }
pbsfun()
```
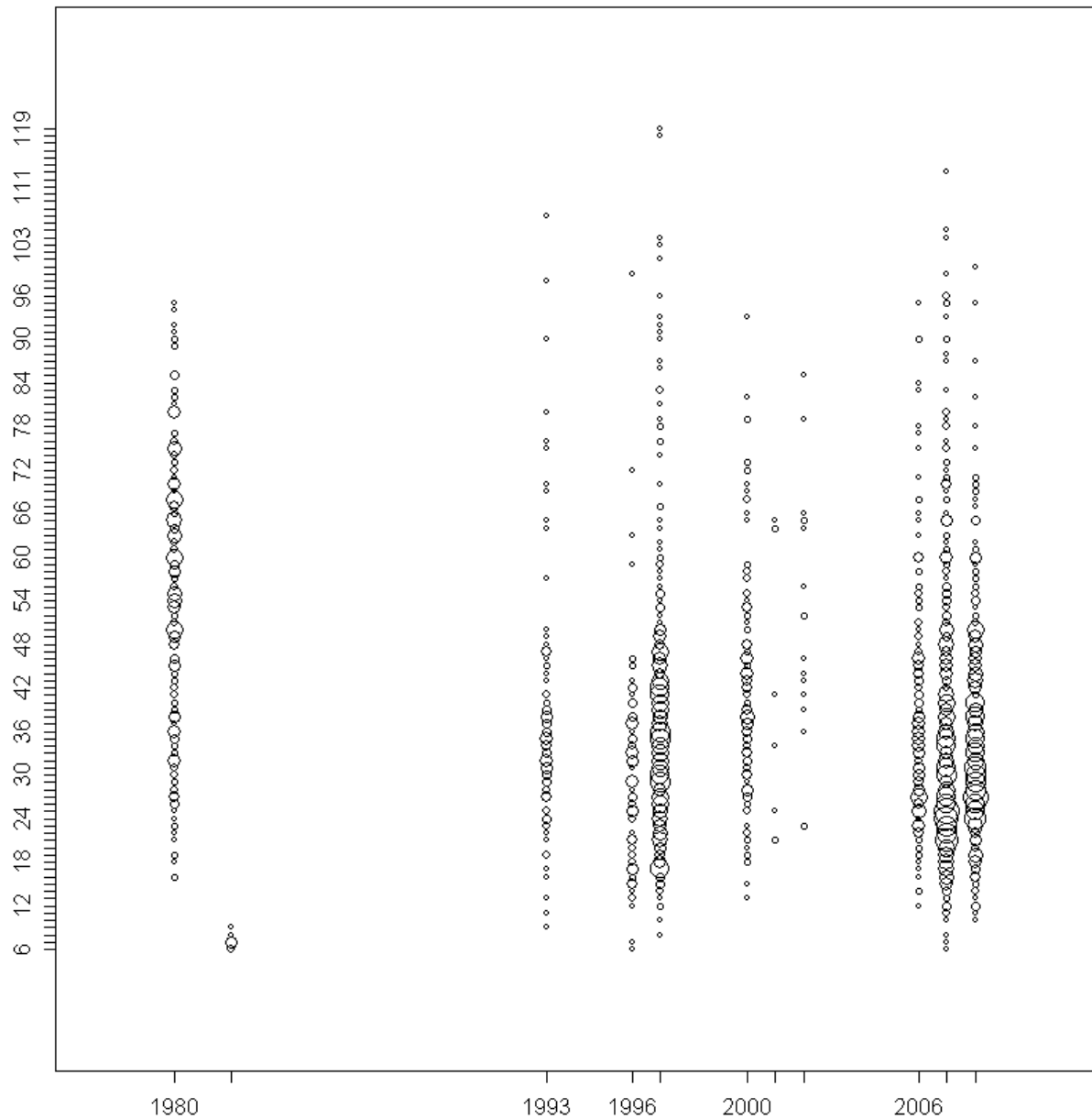
Figure 18. An age frequency matrix by calendar year for Rougheye Rockfish (*Sebastes aleutianus* + *S. melanostictus*) from research surveys along the BC coast (Haigh *et al.*, 2005).

Example code for `nage394`:

```
pbsfun=function(){
  require(PBSmodelling); data(nage394)
  plotBubbles(nage394,dnam=TRUE,hide0=TRUE,size=0.1)
  invisible() }
pbsfun()
```
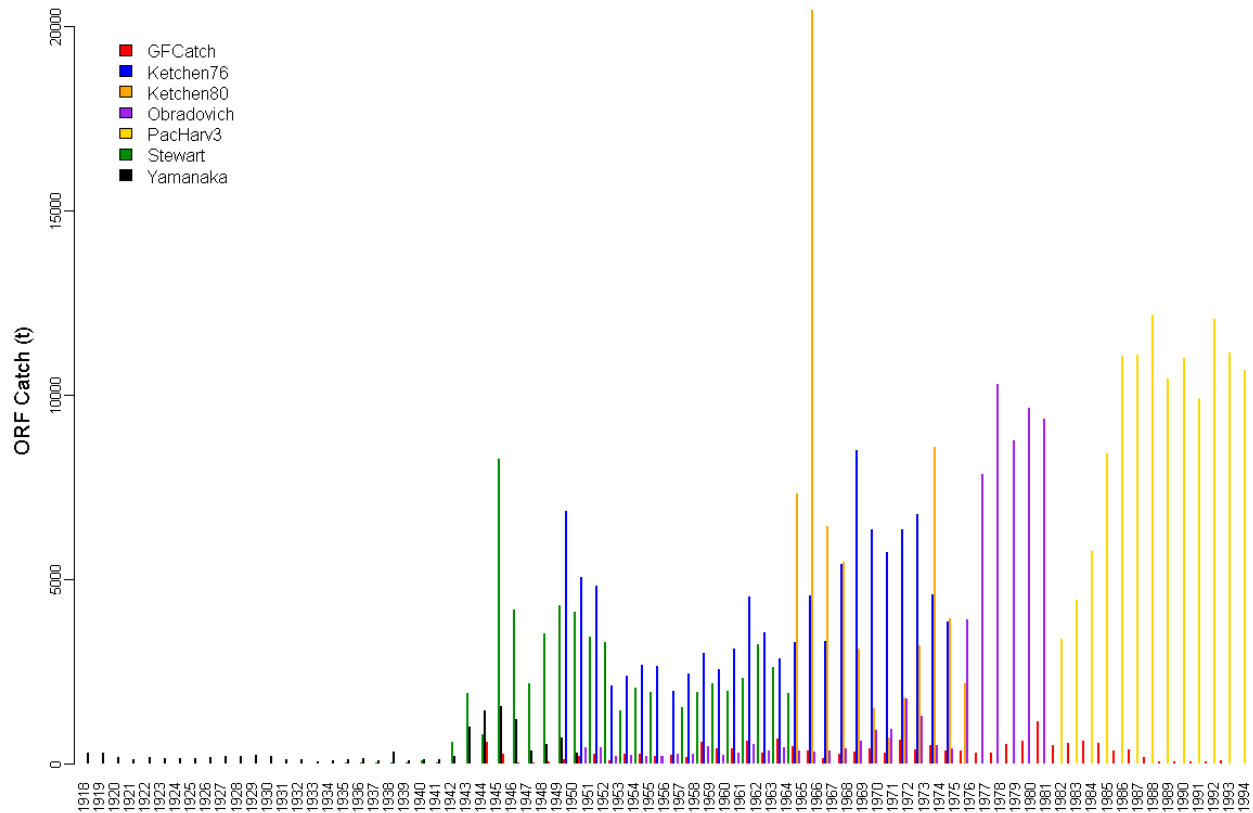
Figure 19. Barplot showing the various historical records of total rockfish (t) other than Pacific Ocean Perch. In years where sources overlap, the catch reconstruction (Haigh and Yamanaka, 2011) either sums the catches or takes the maximum, depending on the source (CDBS, 1918–1950; Ketchen, 1976, 1980; Rutherford, 1999; Thomson and Yates, 1960, 1961).

Example code for `orfhistory`:

```
pbsfun=function(dat, spp="396", ...){
require(PBStools); data(orfhistory)
dat  = dat[is.element(dat$spp,spp),]
ctab = crossTab(dat,c("year","source"),"catch",function(x){sum(x)/1000})
out  = as.data.frame(ctab[,-1]); row.names(out)=ctab[,1]
sou  = dimnames(out)[[2]]; nsou = length(sou)
clrs = c("red","blue","orange","purple","gold","green4","black","pink")[1:nsou]
expandGraph(mar=c(3,3,.5,.5))
evalCall(barplot,argu=list(height=t(out),beside=TRUE,col=clrs,border=FALSE,type="h",
space=c(0,0),las=3,cex.axis=.8,cex.names=.8,xaxs="i"),...,checkdef=TRUE,checkpar=TRUE)
legend("topleft",bty="n",fill=clrs,legend=sou,inset=.025)
mtext("ORF Catch (t)",side=2,line=2,cex=1.2)
invisible(out)
}
x = pbsfun(orfhistory,spp=c("388","389","391"),space=c(0,0))
```
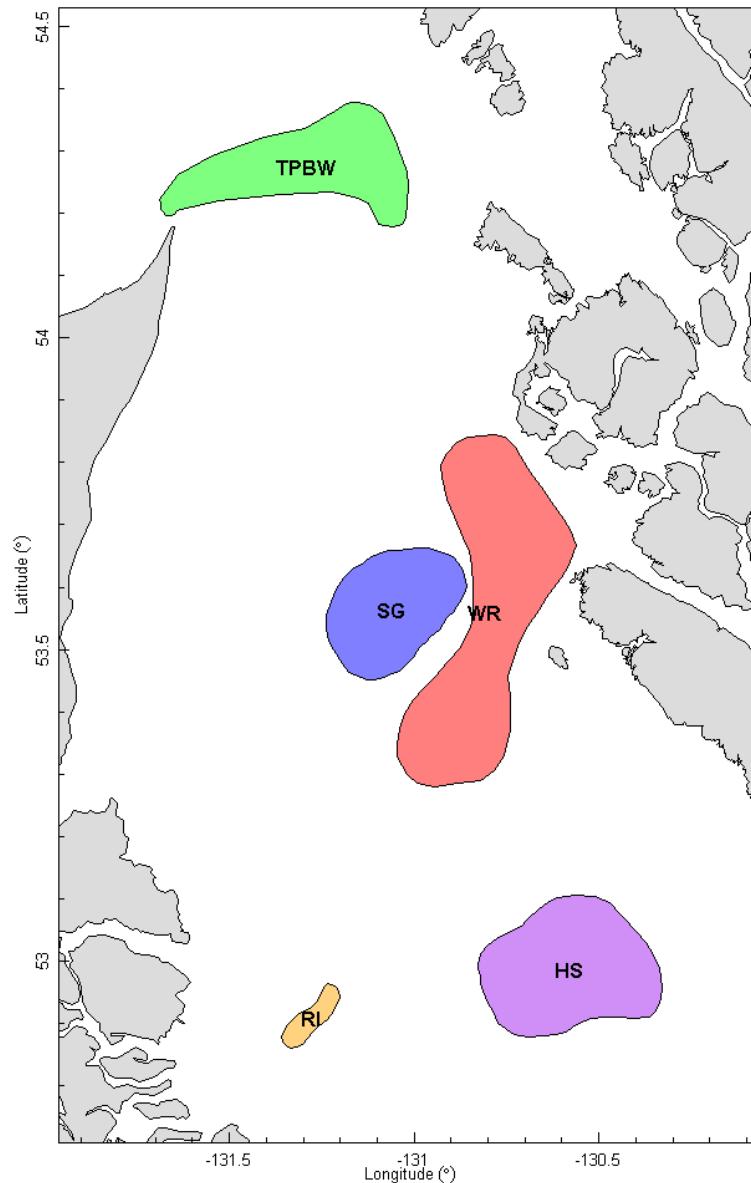
Figure 20. Simple polygons that outline the Hecate Strait Pacific Cod Monitoring Survey areas: TPBW = Two Peaks/ Butterworth, SG = Shell Ground, WR = White Rocks, RI = Reef Island, HS = Horseshoe (Sinclair and Workman, 2002; Sinclair and Starr, 2005).

Example code for `pcoda`:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL,pcoda)
  xlim=extendrange(pcoda$X,f=0.2); ylim=extendrange(pcoda$Y,f=0.1)
  plotMap(nepacLL,xlim=xlim,ylim=ylim,plt=NULL,col="gainsboro")
  pdata=attributes(pcoda)$PolyData
  addPolys(pcoda,polyProps=pdata)
  addLabels(pdata,polys=pcoda,placement="CENTROID",font=2)
  invisible() }
pbsfun()
```

Footnote in Forrester (1969):

In 1956, informal agreement was reached among various research agencies along the Pacific coast to establish a uniform description of fishing areas as a means of coordinating the collection and compilation of ottertrawl catch statistics.

This work was undertaken by the Pacific Marine Fisheries Commission (representing the States of Washington, Oregon, and California) with the informal cooperation of the Fisheries Research Board of Canada.

Areas 1A, 1B, and 1C encompass waters off the California coast, while Areas 2A-2D involve waters adjacent to Oregon and a small part of southern Washington.

The remainder of the Washington coast and the waters off the west coast of Vancouver Island comprise Areas 3A-3D, while United States and Canadian inshore waters (Juan de Fuca Strait, Strait of Georgia, and Puget Sound) are represented by Areas 4A and 4B, respectively.

Fishing grounds between the northern end of Vancouver Island and the British Columbia-Alaska boundary are represented by Areas 5A-5E.

The entire Alaskan coast is designated as Area 6, but except for a small amount of fishing in inshore channels, this area has not been trawled intensively by North American nationals.

Figure 21. Pacific Marine Fisheries Commission (PMFC) areas ued by DFO groundfish personnel (see `major`). These are based largely on the original definitions set up by the US PMFC and the Fisheries Research Board of Canada (Forrester, 1969; Tagart, 1991).

Example code for `pmfc`:

```
pbsfun=function(){
  data(pmfc)
  mess=attributes(pmfc)$history
  plot(-1:1,-1:1,type="n",axes=FALSE,xlab="",ylab="")
  text(0,0,paste(strwrap(mess,width=80),collapse="\n"),col="blue",cex=.8)
  invisible() }
pbsfun()
```
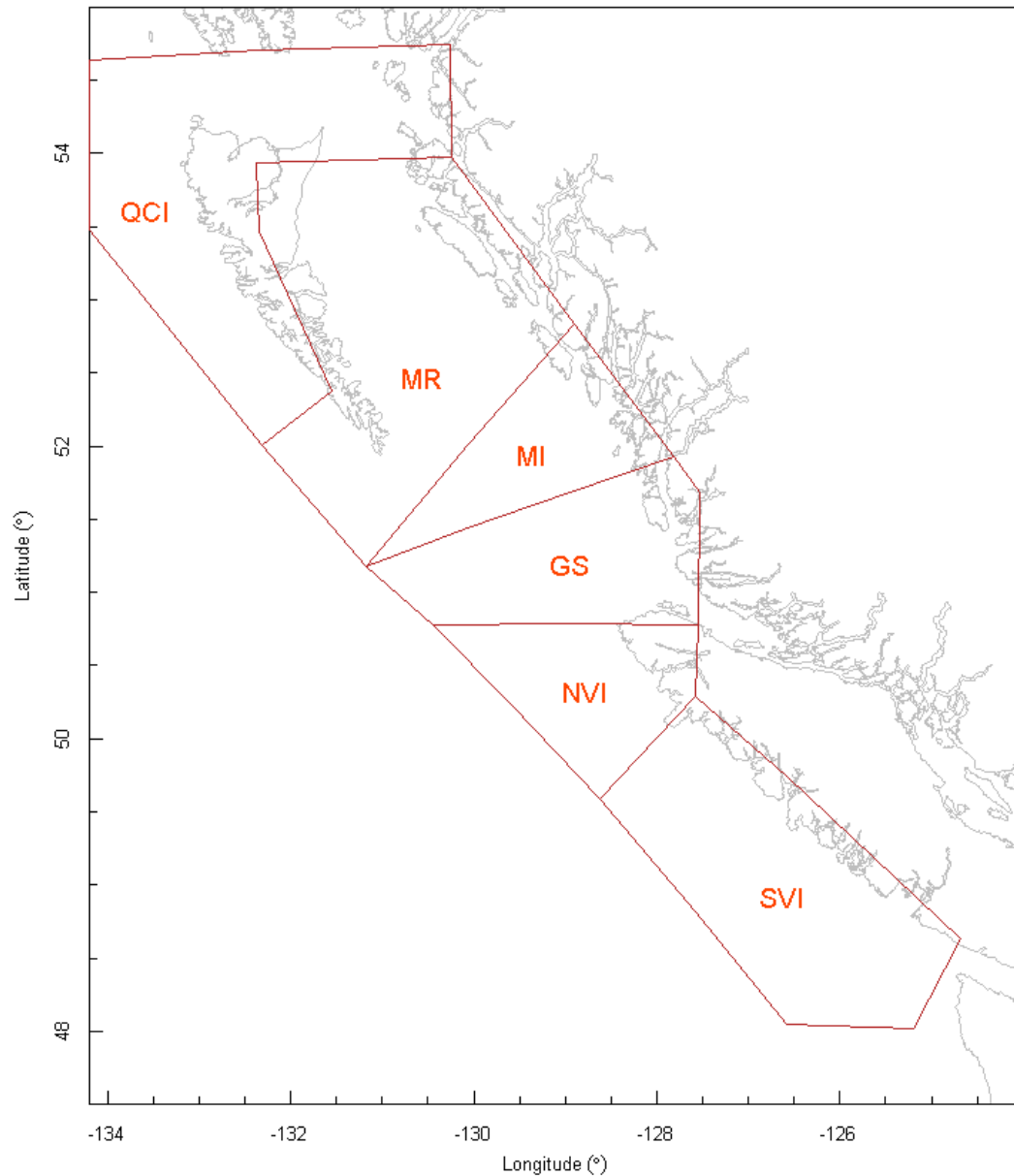
Figure 22. PolySet of polygons for areal boundaries that delimit Pacific Ocean Perch (*Sebastes alutus*) population clusters based on POP catch and/or CPUE patterns (Schnute *et al.*, 2001).

Example code for popa:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL,popa)
  plotMap(nepacLL,xlim=c(-134.2,-124),ylim=c(47.5,55),border="grey")
  addPolys(popa,border="firebrick")
  addLabels(attributes(popa)$PolyData,col="orangered",cex=1.2)
  invisible() }
pbsfun()
```
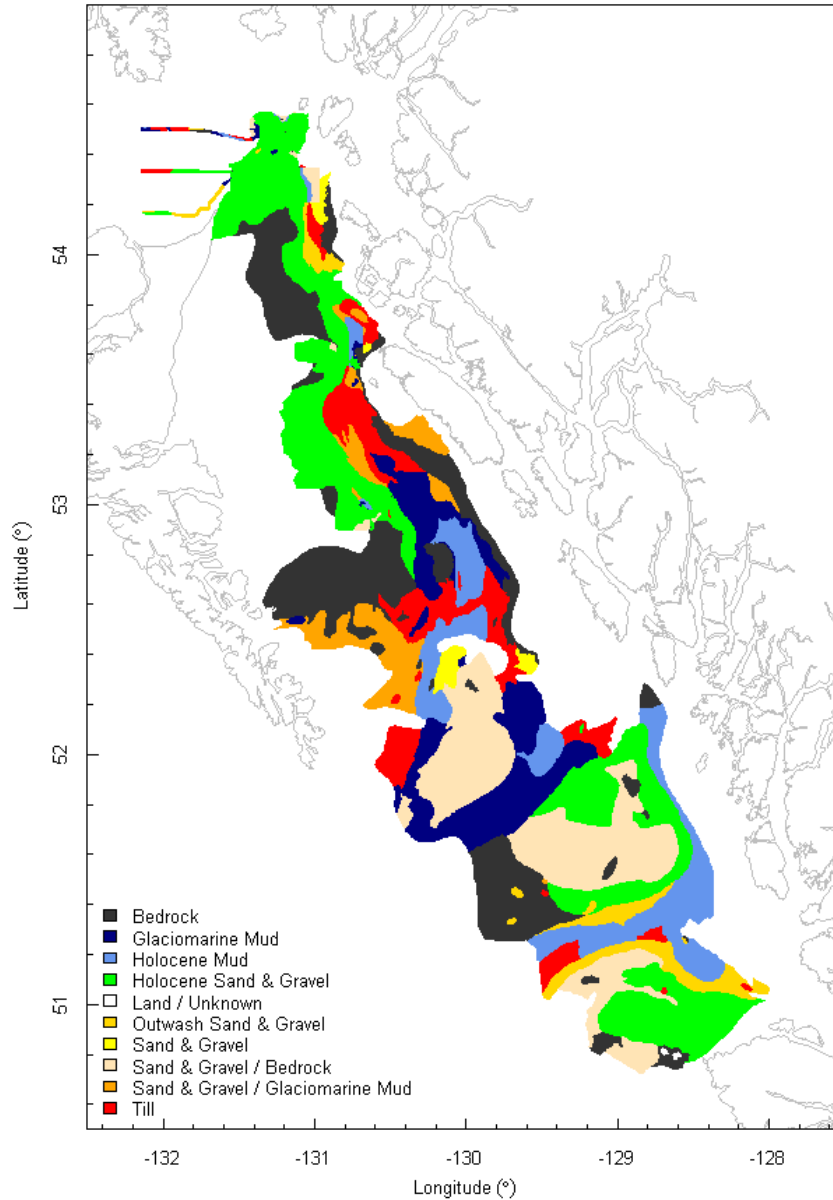
Figure 23. PolySet of polygons describing the surficial geology of Queen Charlotte Sound (QCS) and Hecate Strait (Barrie *et al.*, 1991; Sinclair *et al.*, 2005).

Example code for qcb:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL,qcb)
  pdata=attributes(qcb)$PolyData
  leglab=sapply(split(pdata$label,pdata$col),function(x){y=unique(x);paste(y,collapse=" / ")})
  leglab=leglab[order(leglab)]
  xlim=c(-132.5,-127.5); ylim=c(50.5,55)
  plotMap(nepacLL,xlim=xlim,ylim=ylim,border="grey")
  addPolys(qcb,border=FALSE, polyProps=pdata)
  legend("bottomleft",fill=names(leglab),legend=leglab,bty="n",cex=.8)
  invisible() } ;  pbsfun()
```
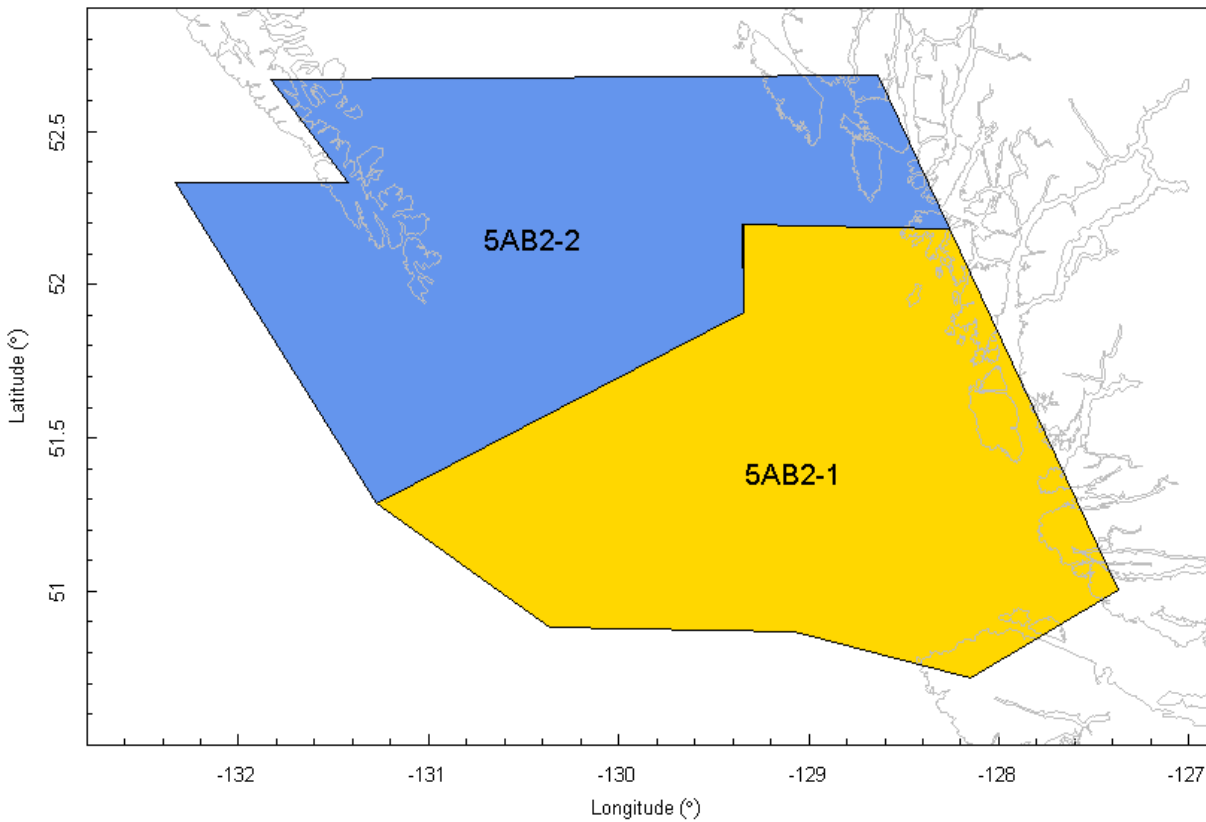
Figure 24. PolySet of polygons describing the survey strata for the Queen Charlotte Sound (QCS) synoptic groundfish survey (Stanley *et al*., 2004).

Example code for `qcssa`:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL,qcssa)
  plotMap(nepacLL,xlim=c(-132.8,-126.9),ylim=c(50.5,52.9),border="grey")
  pdata=attributes(qcssa)$PolyData
  addPolys(qcssa,polyProps=pdata); addPolys(nepacLL,border="grey")
  addPolys(qcssa,border="black");  addLabels(pdata,cex=1.2)
  box(); invisible() }
pbsfun()
```
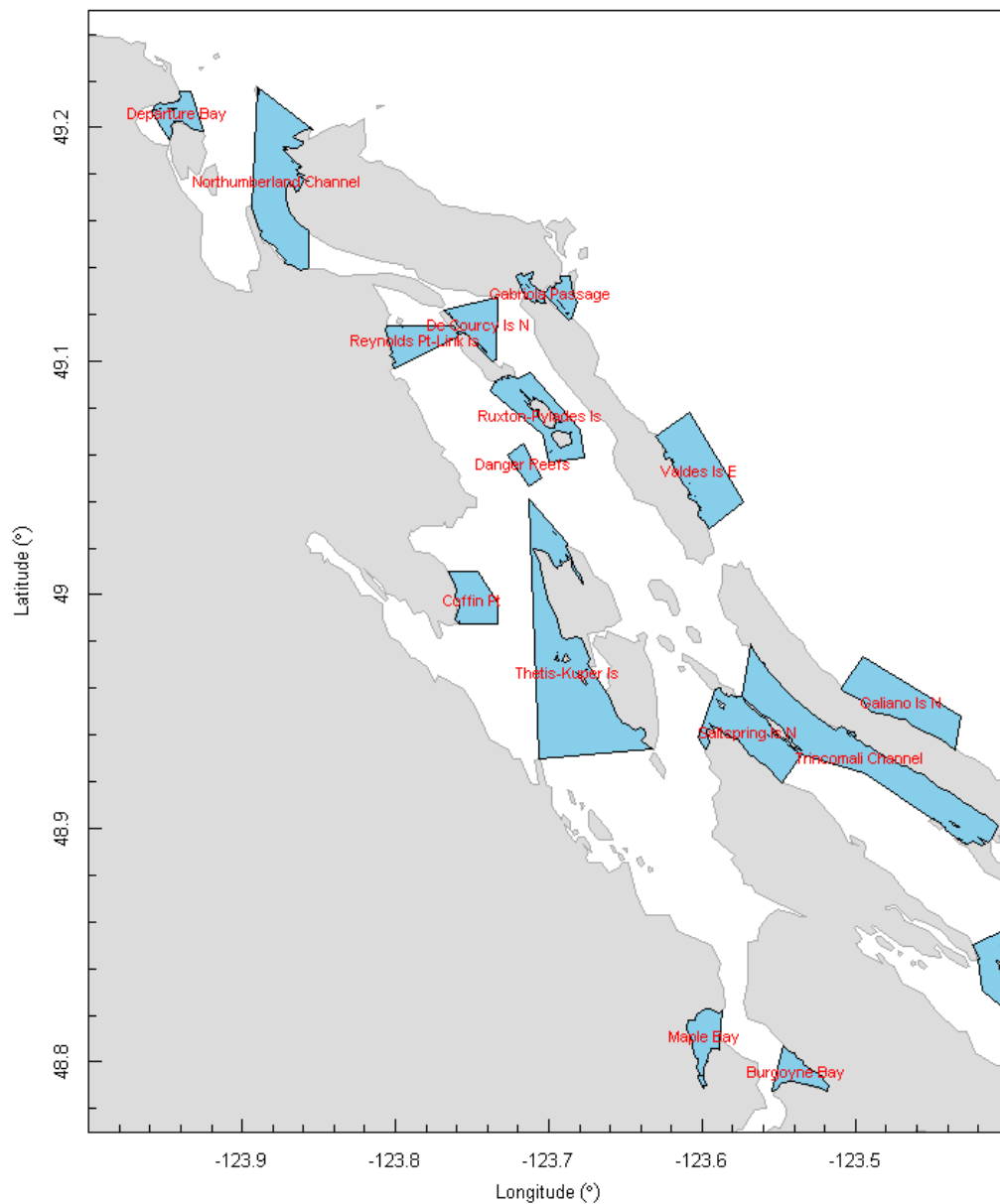
Figure 25. PolySet of polygons for BC inshore Rockfish Conservation Areas 2007 (DFO, 2006).

Example code for `rca`:

```
pbsfun=function(xlim=c(-124,-123.4),ylim=c(48.77,49.25)){
  require(PBSmapping); data(nepacLLhigh,rca)
  plotMap(nepacLLhigh,xlim=xlim,ylim=ylim,col="gainsboro",border="darkgrey")
  pdata=attributes(rca)$PolyData
  addPolys(rca,col="skyblue")
  addLabels(pdata,cex=0.65,polys=rca,placement="CENTROID",col="red")
  box(); invisible() }
pbsfun()
```
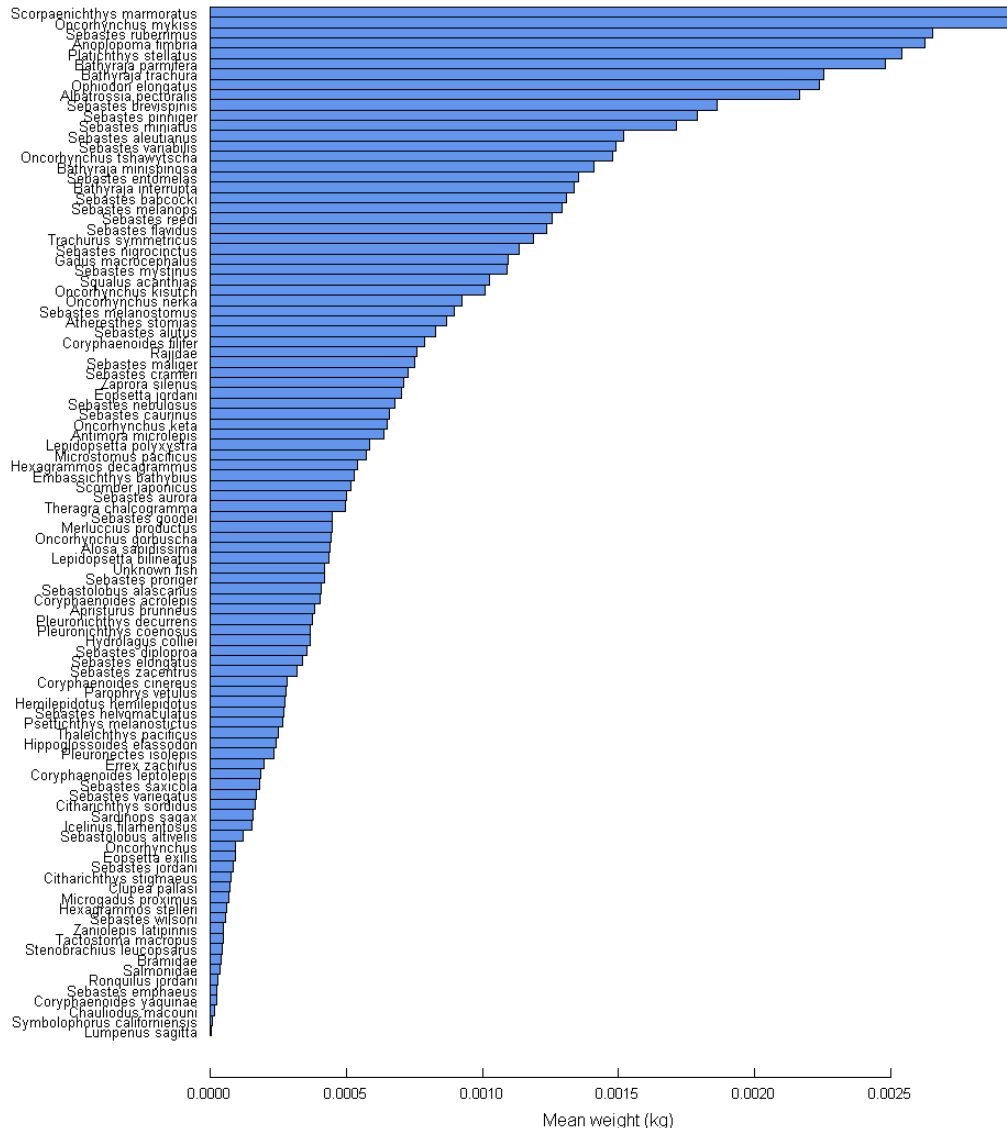
Figure 26. Mean weight in data frame `species` identified primarily by Hart (1973) codes. The information resides in a data table called `C_Species` in the relational database `PacHarvest`, and is supplemented with data from `GFBIO`.

Example code for `species`:

```
pbsfun=function(N=100){
  data(species);  oldpar=par(no.readonly=TRUE); on.exit(par(oldpar))
  par(mar=c(3,10,0,1),las=1,mgp=c(0,.2,0),tck=.01)
  spp=species[species$gfbrwt>0 & !is.na(species$gfbrwt),]
  spp=spp[(order(spp$gfbrwt)),]
  spw=spp$gfbrwt/1000; names(spw)=spp$latin
  if (is.null(N) || N<=1) N=length(spw)
  x=1:N; xlim=c(1,N); ylim=c(0,max(spw))
  barplot(spw[x],space=0,names.arg=names(spw)[x],horiz=TRUE,
    col="cornflowerblue",las=1,cex.names=.8,cex.axis=.8)
  mtext("Mean weight (kg)",side=1,line=1.5,cex=1); invisible() } ;  pbsfun()
```
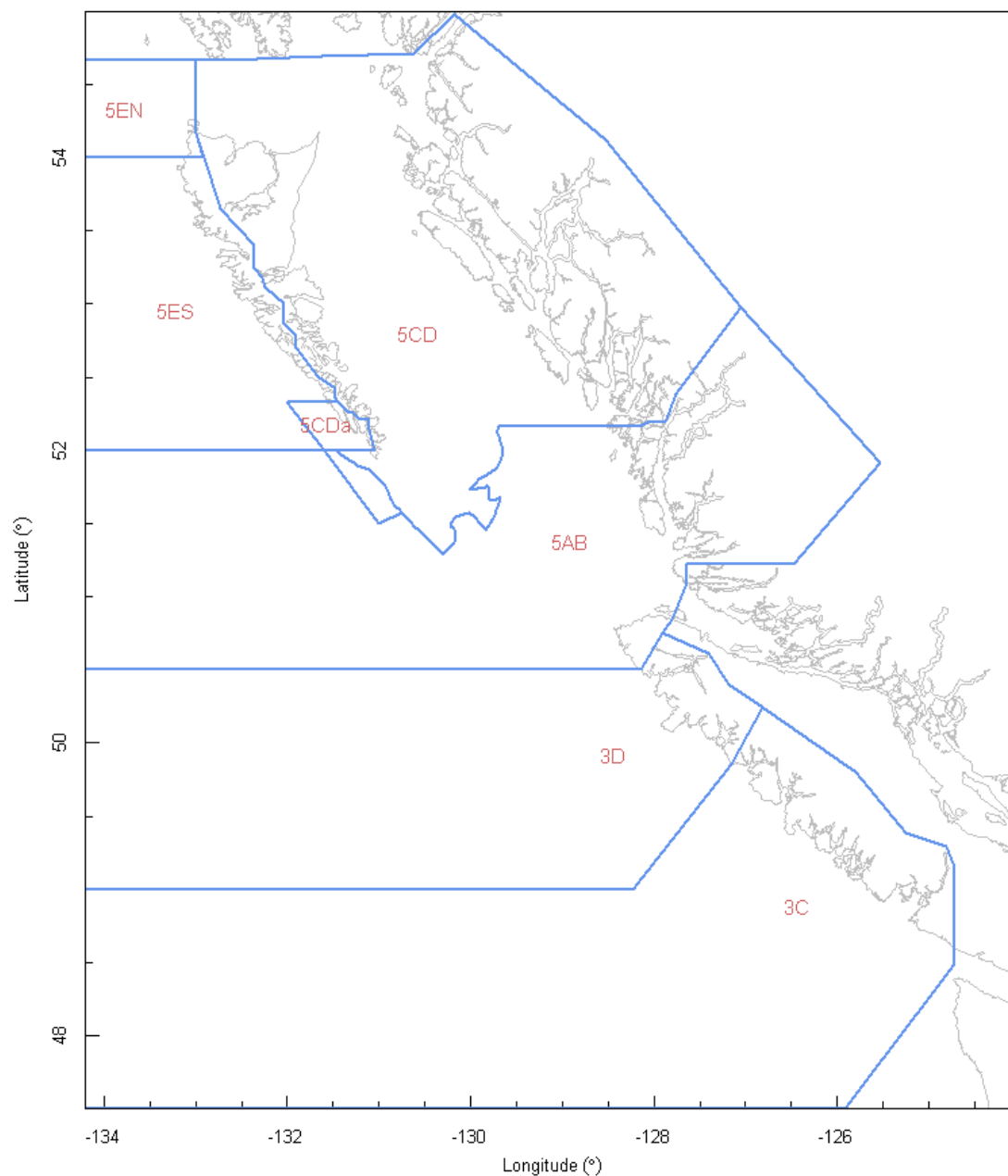
Figure 27. PolySet of polygons for areal boundaries used in slope rockfish assessments (Schnute *et al.*, 2001).

Example code for `srfa`:

```
pbsfun=function(){
  require(PBSmapping); data(nepacLL,srfa)
  plotMap(nepacLL,xlim=c(-134.2,-124),y=c(47.5,55),border="grey")
  addPolys(srfa,border="cornflowerblue",lwd=2)
  addLabels(attributes(srfa)$PolyData,col="indianred",cex=0.9)
  box(); invisible() }
pbsfun()
```
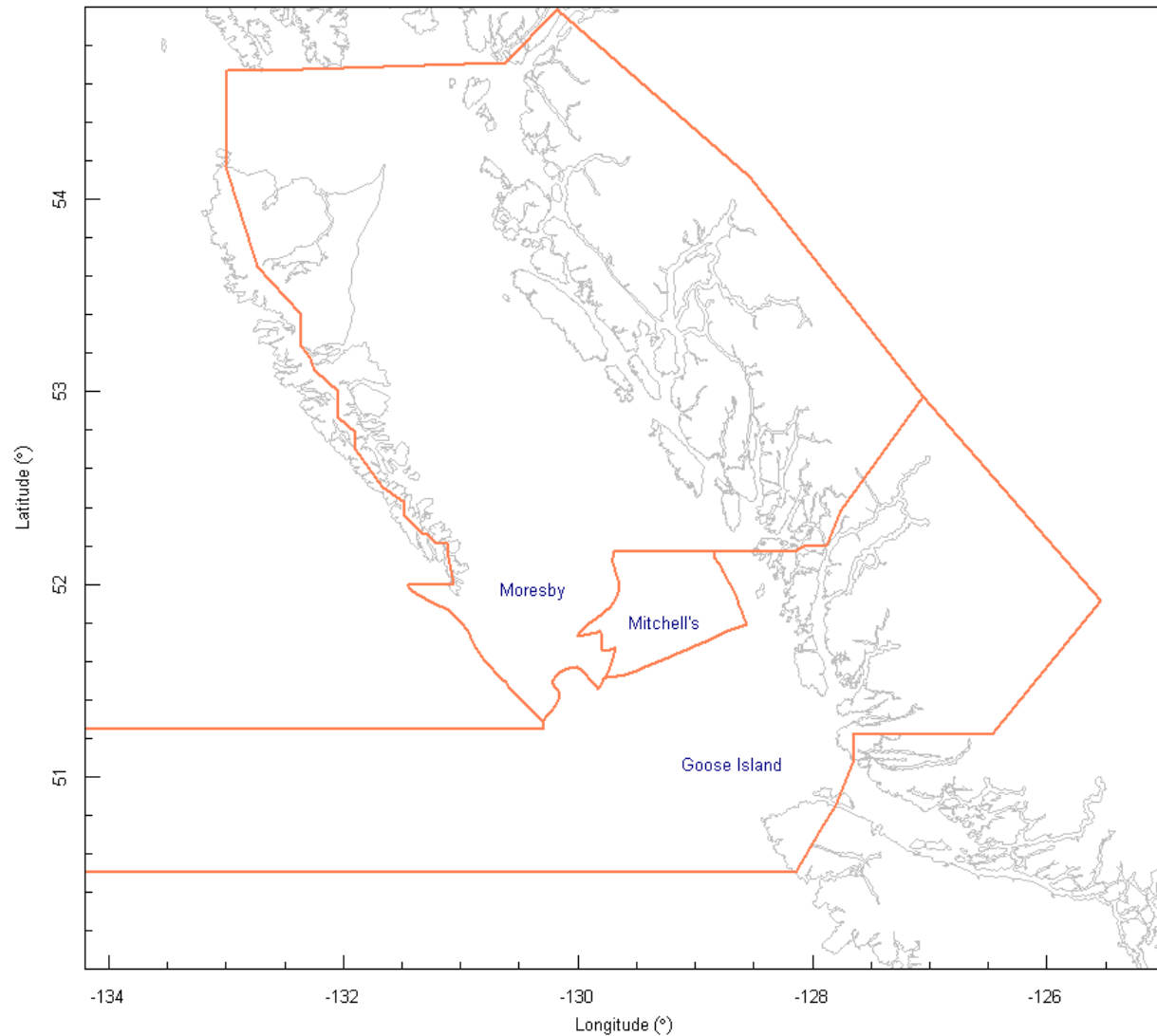
Figure 28. PolySet of polygons for Queen Charlotte Sound (QCS) gullies used in slope rockfish assessments (Schnute *et al.*, 2001).

Example code for `srfs`:

```
pbsfun=function(){
  require(PBSmapping); data(srfs,nepacLL)
  plotMap(nepacLL,xlim=c(-134.2,-125),y=c(50,55),border="grey")
  addPolys(srfs,border="coral",lwd=2)
  addLabels(attributes(srfs)$PolyData,col="navy",cex=0.8)
  box(); invisible() }
pbsfun()
```
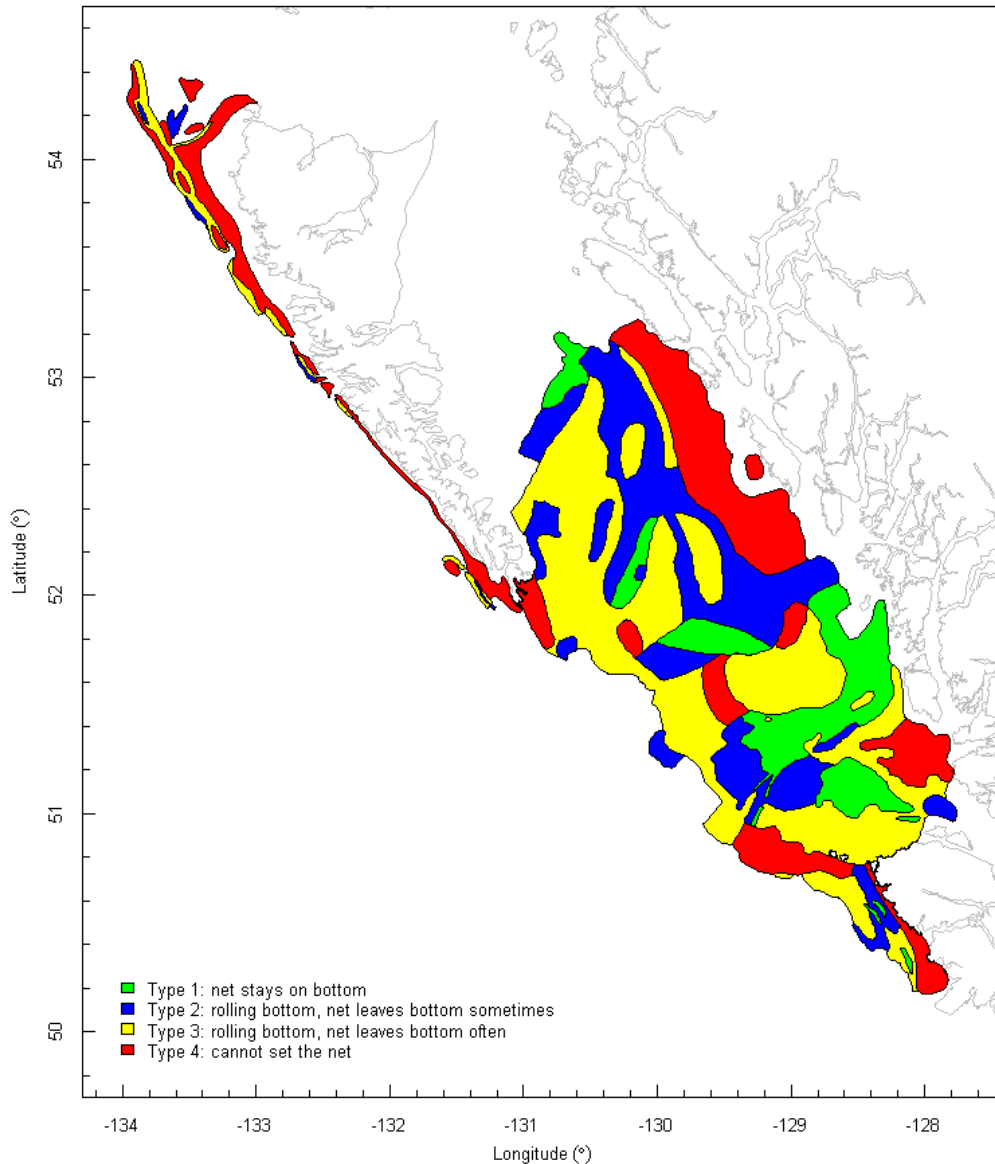
Figure 29. PolySet of polygons describing areas of 'trawlability' on the central coast of BC (Queen Charlotte Sound) and the west coast of The Queen Charlotte Islands (Schnute *et al.*, 1999).

Example code for `trawlability`:

```
pbsfun=function(){
  require(PBSmapping); data(trawlability,nepacLL)
  pdata=attributes(trawlability)$PolyData
  plotMap(nepacLL,xlim=c(-134.3,-127.4),y=c(49.7,54.7),border="grey")
  addPolys(trawlability,polyProps=pdata)
  leglab=sapply(split(paste(pdata$label,pdata$brief,sep=": "),pdata$col),unique)
  leglab=leglab[order(leglab)]
  legend(x="bottomleft",fill=names(leglab),legend=leglab,bty="n",cex=.8,inset=.025)
  box(); invisible() } ;    pbsfun()
```
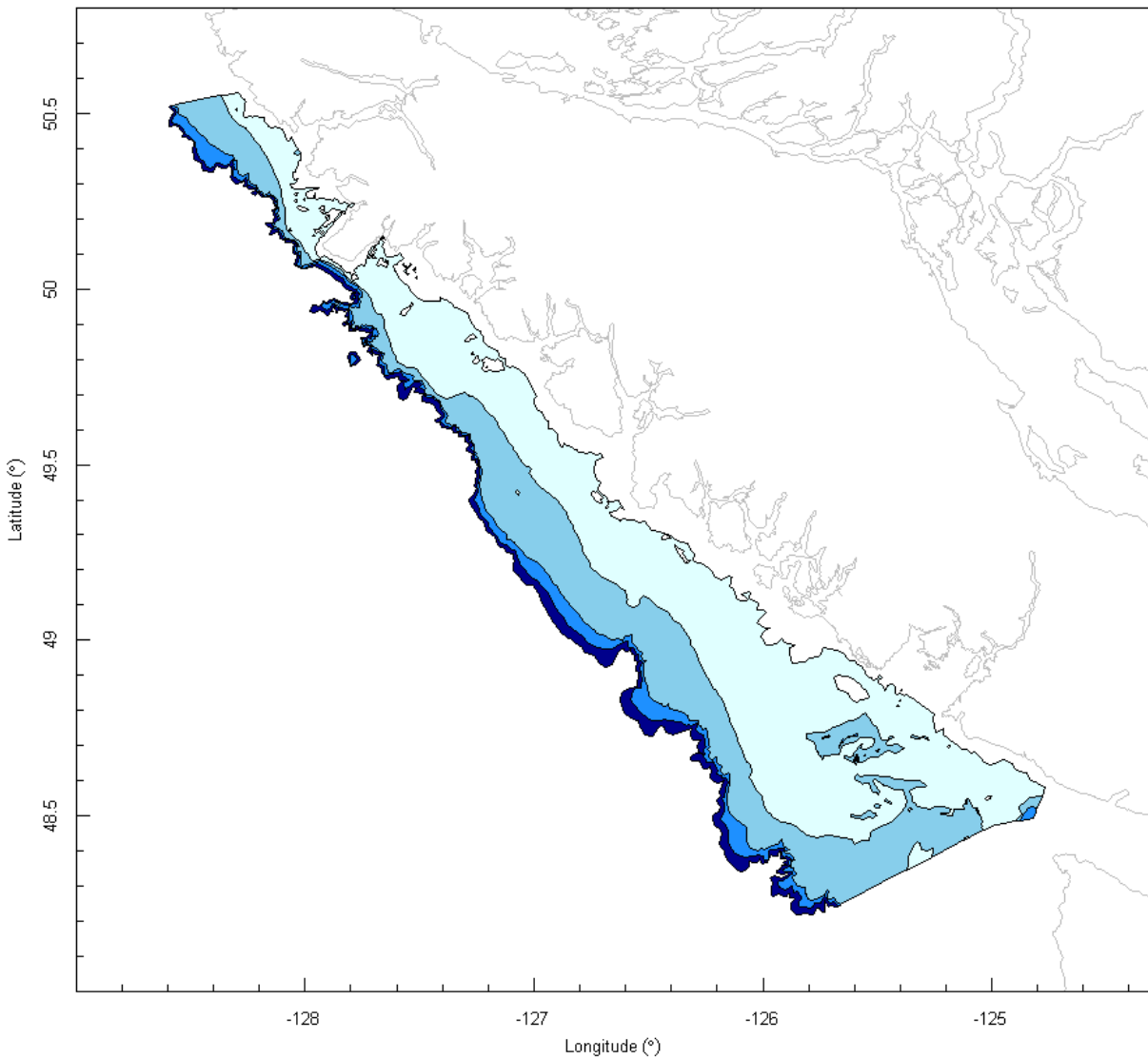
Figure 30. PolySet of polygons describing the survey strata for the west coast of Vancouver Island synoptic groundfish survey (Schnute *et al.*, 2004; Stanley *et al.*, 2004).

Example code for `wcvisa`:

```
pbsfun=function(){
  require(PBSmapping); data(wcvisa,nepacLL)
  pdata=attributes(wcvisa)$PolyData
  plotMap(nepacLL,xlim=c(-129.0,-124.3),y=c(48.0,50.8),border="grey")
  addPolys(wcvisa,polyProps=pdata)
  box(); invisible() }
pbsfun()
```