A BATHYMETRIC-BASED HABITAT MODEL FOR YELLOWEYE ROCKFISH (*SEBASTES RUBERRIMUS*) ON ALASKA'S OUTER KENAI PENINSULA

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THESIS

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ABSTRACT

Motivated primarily as part of a habitat-based stock assessment, we explored the feasibility of modeling yelloweye rockfish (*Sebastes ruberrimus*) habitat in Southcentral Alaska using high-resolution multibeam bathymetry. A generalized linear model was developed with bathymetrically derived terrain metrics (rugosity, slope, bathymetric position index, and distance-to-rock) as predictor variables. The model was parameterized and validated using remotely operated vehicle observations. When evaluated for the Chiswell Island training area, the model correctly classified 96.0% (n = 100) of a reserved set of presence/absence validation points (Cohen's Kappa = 0.92; AUC = 0.98). When evaluated for the independent Nuka Island testing area, the overall accuracy was 82.5% (n=332; Kappa = 0.65; AUC = 0.95). This study demonstrates that suitable yelloweye habitat can be modeled with reasonable accuracy using high-resolution multibeam bathymetry, and such a model is fairly portable among sites along the Kenai Peninsula's outer coast.

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GENERAL INTRODUCTION

Habitat models and species distribution models predict the potential or realized distribution of a species based on environmental variables. They have been applied to a variety of fishery management and conservation issues such as: identifying potential marine protected areas (Ardron et al. 2002; Ardron and Wallace 2005; Embling et al. 2010); and delineating essential fish habitat, as mandated by the Magnuson-Stevens "Sustainable Fisheries Act" (DOC 1997; Valavanis et al. 2004, 2008; Rooper et al. 2014; Miller et al. 2015). The habitat model presented here was motivated primarily for use as part of a habitat-based abundance estimate for yelloweye rockfish (*Sebastes ruberrimus*) in southcentral Alaska.

Manned submersible, or more cost effective Remotely Operated Vehicle (ROV), surveys have become the standard method for estimating the density of demersal rockfish, largely because the rocky habitat where these species occur precludes traditional trawl surveys, and closed swim bladders embolize when brought to the surface (O'Connell and Carlile 1993, 1994; Nasby-Lucas et al. 2002; Johnson et al. 2003; Yoklavich 2007; Byerly et al. 2007, 2015; Green et al. 2014). Traditionally the habitat delineations used in habitat-based rockfish assessments have been derived from visually interpreting bathymetric survey data, usually by a trained expert familiar with the local geology and characteristics of the specific type of sonar product (Greene et al. 1999, 2007; Nasby-Lucas 2002; Yoklavich et al. 2007). The disadvantage of this method is that it is time consuming, reliant on the availability of a particular expert, and because it is subjective, is prone to bias and non standardization among areas. In contrast, the purely analytic algorithmic approach presented here should yield cost-effective, reproducible, standardized results among areas.

In Chapter 1 I provide an overview of the field of habitat modeling with particular focus on the problems inherent to unreliable absences and the methods developed in response. I also provide background information on the biology and management of yelloweye in Alaska.

Techniques have been previously developed for modeling the distribution of three species of rockfish — rosy (*S. rosaceus*), yellowtail (*S. flavidus*), and greenstriped (*S. elongatus*) — off the coast of California using submersible observations and high-resolution multibeam bathymetry (Iampietro et al. 2005, 2008; Young et al. 2010). In Chapter 2, I capitalize on previously acquired analogous data (Byerly et al. 2007, 2015) to explore the feasibility of using a similar approach to model the distribution of yelloweye rockfish habitat in southcentral Alaska.

CHAPTER 1

BACKGROUND:

AN OVERVIEW OF HABITAT MODELING, AND

THE BIOLOGY & MANAGEMENT OF DEMERSAL ROCKFISH IN ALASKA

1.1 HABITAT MODELS

Ecologists have long recognized that the ecological requirements of species, loosely described as their niches, and their distributions are related. Hutchinson (1957) defined an environmental niche as the n-dimensional hypervolume in the multidimensional space of environmental factors that affect the welfare of a species. Realizing the range of conditions under which a species could potentially exist is greater than the range of conditions under which a species actually does exist, especially after the effects of predation and competition, he distinguished fundamental from realized niches. Habitat models in essence, project this multidimensional hypervolume of a niche onto the three dimensions of physical space, and, less commonly, time. More concretely, habitat models predict the distribution of a species' habitat — either fundamental if predicted from theoretical physiological constraints, or realized if derived from field observations — based on environmental variables, with habitat defined as the place where an organism is ordinarily found (Begon et al. 2006; Araju and Guisan 2006).

Habitat modeling has become commonplace over the past few decades with the proliferation of geographic information systems (GIS) facilitating the integration of increasingly available spatial environmental and species occurrence datasets over large areas. Early habitat models focused on the terrestrial realm, largely because collecting data — both species presence and environmental — was easier on land than underwater, particularly over large spatial extents because most satellite and airborne remote sensing technologies do not penetrate the sea surface, and also because of the temporal variability and dynamics of water bodies (Valavanis et al. 2008). Plants, because of their permanence, and highly terrain dependent species of animals, such as mountain goats, were among the earliest species to be successfully modeled with GIS-based habitat models (Fischer 1990; Fitzgerald and Lees 1993; Holmes 1993; Gross 2002).

Despite the challenges associated with modeling marine habitats, interest has exploded over the past two decades, largely because of the growing availability of spatially explicit marine environmental datasets, especially high-resolution remotely-sensed bathymetry collected using multibeam echo sounders (MBES) (Iampietro et al. 2005; Valavanis et al. 2008; Brown and Blondel 2009). Although MBES have widely emerged as the tool of choice for seafloor habitat modeling, primarily because of their ability to collect both bathymetry and backscatter information simultaneously over a full coverage swath of the seafloor, the older single beam acoustic ground discrimination systems and side scan sonars both have their respective merits and have also both been employed with some degree of success in marine benthic habitat models (Parnum et al. 2009).

The popularity of habitat modeling has generated a diverse array of habitat models. While an exhaustive review of the various model types is beyond the scope of this study, a brief overview of the field is warranted. Beginning with the commonalties, in virtually all habitat models: (1) the study area is depicted as a raster map, that is, a full coverage geospatial grid of equally sized adjacent cells; (2) each cell is assigned values for a range of environmental variables to form the set of independent variables; (3) the dependent variable is the species occurrence data observed for a subset of the cells; and (4) the habitat model itself is the function which classifies the cells of the study area as accurately as possible as either suitable or unsuitable habitat based on the environmental variables (Hirzel et al. 2002). A major distinction amongst the huge array of published habitat models relates to the type of species occurrence data used, specifically whether a model requires: (1) presence and absence data; or (2) presence data only.

Presence/Absence Models

Presence/absence models, which use group discriminative analyses, were developed first and are more classically intuitive. Here the species distribution data contain both presence and absence points. Regression based generalized linear models (GLMs), and their even more generalized extension generalized additive models (GAMs), are the most popular types of presence/absence habitat models currently in use. Much of their popularity over ordinary multiple regression is due to the ease at which they accommodate non-normally distributed and heteroscedastic predictor variables including ordinal and even categorical data. Another major advantage of GLMs is that they can constrain the response variable to a meaningful range of values through the use of a link function which relates the linear predictor — the linear combination of environmental variables and their parameters — to the response variable. For example, in species habitat modeling the response variable is commonly desired to be binomially distributed within the range of 0 (unsuitable) to 1 (suitable). In this case, the logit function is used to linearize the binomially distributed response variable and relate it to the linear predictor. Other popular presence/absence habitat models include canonical correspondence analysis (e.g. for rockfish, Stein et al. 1992), ensembles of regressions or classification trees (e.g., Moore et al. 2009), and neural networks (e.g., Fizgerald and Lees 1993). One of the main advantages of presence/absence models over presence-only models is that their accuracy is easily evaluated by comparing the predictions output from the model to observed presence and absence points. The main disadvantage of presence/absence models is that they require absence points.

A common problem in habitat distribution modeling is the unreliability of absence points. While the observation of a species guarantees both presence and suitability of habitat at that location, the inverse is not true; lack of detection at a point does not necessarily indicate that that point is unsuitable habitat. Habitat modelers have termed these locations *false absences* (Hirzel 2002). False absences arise from either of two situations: (1) the species was in fact at that location but was not detected; or (2) the species really was not at that location, even though the habitat was suitable. The first situation is especially common when dealing with small, inconspicuous, or otherwise hard to detect organisms, and can be accounted for with occupancy estimation techniques, although these require repeat sampling, where occupancy is modeled as the product of probability of detection and the probability of occurrence (Mackenzie et al. 2006; Kery 2010). The second situation is typical of rare and especially heavily exploited populations where the realized niche is small relative to the fundamental niche. Here exploitation, predation, competition, or other factors keep a species confined to a small area of occupied habitat relative to the greater amount of available suitable habitat (Soberón 2007). The second situation also occurs when an ecosystem has not reached static equilibrium, as in the case with recently introduced invaders or colonizers, or never will, in the dynamic case of metapopulations.

Presence-Only Models

Largely as a way to circumvent the aforementioned difficulties associated with unreliable absence points, methods have been developed to model species habitat distributions using only presence points. Also known as profile methods, these approaches do not require absence points for fitting. Instead of comparing the environmental characteristics of the set of presence points to the absence points, profile methods compare the environmental characteristics of the presence points to the background environmental characteristics, where background is defined as the greater study area. They compare the realized niche to the totality of available environmental conditions. The first widely known profile habitat modeling method was the climatic envelope approach developed by Australian botanists in the 1980s and implemented in the BIOCLIM package (Busby 1991). More recently ecological niche factor analysis (ENFA) was developed and packaged in the Biomapper software (Hirzel et al. 2002), which has been at least partially superseded by the maximum entropy method implemented in the MaxEnt program (Phillips et al. 2006). Although attractive because they avoid the problems caused by unreliable absences, presence-only models have certain disadvantages. Chief amongst these disadvantages is the tendency of presence-only models to be overly inclusive in the amount of area they classify as habitat (Hirzel et al. 2002). This tendency has been attributed directly to the lack of absence points to restrict the predicted habitat output from the model, thus a 'perfect' habitat model could classify the entire study area as suitable habitat, at least when evaluated using the classic percentage accuracy metrics. Essentially, presence-only models are not penalized for errors of commission (false positives). A related challenge with presence only models is evaluation of their accuracy given the lack of absence data available for validation, although several performance metrics have been proposed (Hirzel et al. 2006; Monk et al. 2010).

Given the advantages and classic familiarity of regression based presence/absence models such as GLMs, yet their often times difficult to satisfy requirement for absence points, techniques have been developed to create pseudo-absences with GLMs. The simplest method is to pick points at random across the entire study area and use these pseudo-absences as actual absences in a presence/absence model such as a GLM (e.g., Hirzel et al. 2001). However, the random selection of this method runs the risk of treating suitable habitat as absence, thereby reducing model performance. To reduce the probability of selecting good habitat as a pseudo-absence, Engler et al. (2004) developed a two-step method wherein the pool of cells from which pseudo-absences are randomly selected is restricted to that subset of the study area identified by a preliminary ENFA as poor habitat. This decreases the probability that a pseudo-absence point is selected from an area that is, in fact, good habitat. Arguably, this two-step ENFA-GLM method combines the respective strengths of the classic regression-based GLM with the presence-only ENFA.

1.2 ROCKFISH

General Biology

Rockfish, (*Sebastes spp.* and *Sebastolobus spp*.; order Scorpaeniformes; family Scorpaenidae) are extremely diverse, with ~102 species worldwide, the majority of which (~96 species), are distributed across the North Pacific (Love et al. 2002). At least 24 species occur along the outer coast of the Kenai Peninsula (Russ et al. 2013). Rockfish have several unique life history characteristics. Eggs are fertilized internally, months after mating, are primitively matrotrophically viviparous, and are parturated as fully formed larvae (Love et al 2002). Extreme longevity — 205 y for rougheye (*S. aleutianus*) and 121 y for yelloweye in Alaska — likely evolved as an adaptation to profound episodic recruitment, wherein decades often separate oceanic conditions supportive of successful recruitments (Munk 2001; O’Connell and Brylinsky 2003). Together these dramatically k-selected life history characteristics (Pianka 1970), along with late maturation (22 y for female yelloweye), low natural mortality, limited dispersal, and closed swim bladders, predispose rockfish, especially demersal species such as yelloweye, to classic vulnerability to overfishing (O’Connell and Funk 1986; Bechtol 1998).

Yelloweye occur at depths of 15–549 m, but are more typically found on hard rocky bottom from 91 to 180 m, with size and age generally increasing with depth (Love et al. 2002; Johnson et al. 2003). They are found from Baja to Umnak I. (Kramer and O’Connell 2004).

In Habitat Models

Rockfish, particularly the demersal species, are excellent candidates for habitat models. Unlike pelagic species which migrate to follow shifting water bodies, demersal rockfish exhibit high site fidelity and are closely associated with permanent rock outcroppings (Carlson and Haight 1972; Johnson et al. 2003; Iampietro et al. 2008; Rooper et al. 2010; Hannah and Rankin 2011; Yoklavich et al. 2000). Yelloweye distributions in Alaska are strongly related to the three-dimensional geomorphology of the seafloor with the highest densities found over areas of broken rock and boulders (Stein et al. 1992; O'Connell and Carlile 1993). Some demersal rockfish may spend their entire lives on the same rock pile (Carlson and Haight 1972; Hannah and Rankin 2011). These rock outcroppings are relatively easy to detect with high-resolution bathymetry (Iampietro et al. 2005; Ardron and Wallace 2005).

Young et al. (2010) successfully modeled the distribution of three species of rockfish — rosy (*S. rosaceus*), yellowtail (*S. flavidus*) and greenstriped (*S. elongatus*) — off California using a combination of submersible observations and multibeam bathymetry. For each species they incorporated several depth derived terrain variables into a binomial logistic GLM to predict the probability of presence for that species (Iampietro et al. 2005, 2008; Young et al. 2010).

North Gulf Fishery

Rockfish of the Kenai Peninsula's outer coast play important ecological roles and have been long pursued by both the commercial and recreational fisheries. For ADF&G (Alaska Department of Fish and Game) commercial groundfish management purposes, the coast is defined as the North Gulf District, part of the Cook Inlet Management Area and bounded on the east by Cape Fairfield and Point Adam to the west (5 AAC 28.305; Figure 1). Commercial harvests in the North Gulf District peaked at 502,000 lb in 1995, but were capped at 150,000 lb in 1998 because of rapid harvest increases, sustainability concerns, and limited stock assessment information (Trowbridge et al. 2008). This cap was based on historical catch averages (Bechtol 1998), similar to a Tier 6 approach applied by the North Pacific Fishery Management Council (NPFMC) for groundfish assessment in which only catch data are available (NPFMC 2014). Harvests have subsequently fluctuated largely in concert with market prices and competing economic opportunities afforded by alternative local fisheries, primarily salmon and halibut, with rockfish reaching a near record low of 25,000 lb in 2007 before climbing to 60,500 lb in 2014 (Trowbridge et al. 2008).

While at least 24 species of rockfish occur in the North Gulf District, catches are dominated by the pelagic black rockfish *S. melanops* and the demersal yelloweye rockfish *S. ruberrimus*, comprising approximately 50% and 30% of the catch respectively (Trowbridge et al. 2008). Pelagic species are harvested mostly using jig gear, while demersal species are harvested mostly with longline. In 2005, the directed fishery for demersal rockfish was eliminated allowing harvest of demersal rockfish only as bycatch, mostly to the halibut and Pacific cod longline fisheries but also incidental to the directed jig fisheries for pelagic rockfish and lingcod (Russ et al. 2013). The current study focused on yelloweye because demersal species are expected to be more conducive to terrain-based habitat models than pelagic species and because yelloweye are more vulnerable to overfishing, with slower growth and maturation, and more limited dispersion than black rockfish (Bechtol 1998; Johnson et al. 2003; Hannah and Rankin 2011). As evidence of their extremely episodic recruitment, in recent years (2001 to 2004) the commercial catch of yelloweye in Lower Cook Inlet has been dominated by fish of a single year class, those recruited in 1969 (Trowbridge et al. 2008).

West Coast Status

Yelloweye abundances off California, Washington, and Oregon are estimated to be at 10% of pre-exploitation levels, far below the customary 25% threshold used to define overfishing (Taylor and Wetzel 2011). Puget Sound yelloweye and two other demersal rockfish species have been listed as threatened under the Endangered Species Act (Drake et al. 2010). The particular life history traits for demersal rockfish in general, and especially yelloweye, suggest that these species will be extremely slow to recover from overfishing, with estimates ranging from 50 to 500 y for Washington yelloweye stocks (Taylor 2011).

Management in Alaska

Management authority for yelloweye in Alaska varies by location and fishery. Recreational fisheries are managed by ADF&G, both within state waters (0-3 nautical miles [nmi] from shore) and within the Exclusive Economic Zone (EEZ; 3-200 nmi). Commercial fisheries in state waters are managed exclusively by the State (5 AAC 28.010). In southeast Alaska, the State also manages yelloweye as part of the demersal shelf rockfish (DSR) fishery in the EEZ through an extended jurisdiction program with oversight by the NPFMC. Commercial DSR fisheries in federal waters outside of southeast Alaska are managed exclusively by the NPFMC.

Despite their ecologic and economic importance and susceptibility to overfishing, neither a comprehensive stock assessment nor a coastwide abundance estimate has been completed for rockfish of the North Gulf District. The current harvest cap is somewhat arbitrary, being based on historic catches, rather than biologically significant reference points (Trowbridge et al. 2008). Information about distribution and abundance is limited, primarily to several index sites along the coast where ADF&G has completed both high-resolution MBES bathymetric surveys and video surveys of rockfish using a Remotely Operated Vehicle (ROV). Habitat-based stock assessments are well suited to species with patchy heterogeneous distributions highly dependent on habitat, such as demersal rockfish (Nasby-Lucus et al. 2002; Yoklavich et al. 2007; Tissot et al. 2007; Rooper et al. 2010).

The management plan for yelloweye in the Southeast Region of Alaska provides a feasible example of how a habitat-based stock assessment might be conducted in the Central Region. Prior to 1992, catch limits in the Southeast Region were based on historic catch averages. Beginning in 1992, catch limits for Southeast yelloweye have been set relative to the fishery-independent biomass estimates based on manned submersible or ROV line transect surveys (O'Connell et al. 1991; O'Connell and Carlile 1993). These biomass estimates are simply the mean densities observed in the submersible or ROV line transects, expanded by an estimate of the total habitat in the district. The habitat delineations have a variety of sources including expert interpretated sidescan and/or multibeam sonar (Greene et al. 1999, 2007), high catch per unit effort (CPUE) as recorded in commercial logbook data buffered by 0.5 km, and rocky features on NOAA nautical charts buffered by 0.5 mi (Green et al. 2014). Of note, O'Connell and Carlisle (1993) only intended these estimates of habitat area for *interim* use until they accomplished their *ultimate goal* of developing a *quantitative predictive model to estimate density of yelloweye rockfish and other DSR species based on one or more parameters reflective of structural habitat complexity*.

The management strategy for yelloweye in the North Gulf District is not yet as developed as in the Southeast Region. The ADF&G is gaining a reasonable estimate of yelloweye densities within habitat strata based on ROV video surveys conducted at several index sites along the outer coast, however no coastwide abundance estimate can be calculated because the total area of habitat in the district is not yet known. The current project aimed at this knowledge gap by investigating the feasibility of modeling the distribution of yelloweye habitat using remotely sensed MBES bathymetry. Unlike the Southeast Region, habitat in the Central Region cannot be estimated from logbook data because logbooks are not required of Central Region commercial harvesters. Full coverage multibeam surveys have been completed for the entirety of the index sites mentioned previously in addition to a course grid (~4 km survey line spacing) over most of the remaining coast (Figure 1). Conceptually, the habitat model produced by this project will serve as a bridge to convert multibeam bathymetry to predicted rockfish habitat, and at least partially realizes the objective proposed by O'Connell and Carlisle (1993) 22 years ago.

CHAPTER 2

A BATHYMETRIC-BASED HABITAT MODEL FOR YELLOWEYE ROCKFISH ON ALASKA’S OUTER KENAI PENINSULA

2.1 INTRODUCTION

Several life history characteristics predispose demersal rockfish such as yelloweye rockfish (*Sebastes rubberimus*), to being classically vulnerable to overexploitation. Chief amongst these characteristics are their profoundly k-selected traits of low productivity, episodic recruitment, late maturation, and low dispersion. Furthermore, demersal rockfish are difficult to survey using traditional methods because their rocky habitat precludes trawl surveys, and closed swim bladders embolize when brought to the surface, thereby inhibiting extractive mark recapture surveys (Gotshall 1964). Yelloweye stocks off the west coast of the United States are severely overfished with abundances currently estimated at ~10% of pre-exploitation levels and the Puget Sound population segment listed as threatened under the Endangered Species Act in 2010 (Drake et al. 2010; Taylor and Wetzel 2011).

Despite their susceptibility to overfishing, ecological importance, and economic value in both recreational and commercial fisheries, neither a comprehensive stock assessment nor a districtwide abundance estimate has been completed for yelloweye in Southcentral Alaska. Instead catch limits are static and based on historic catch averages (5 AAC 28.365). Preferably, catch limits are set relative to biologically significant reference points such as an estimate of abundance or biomass. Perhaps the most effective method of estimating the abundance of a heterogeneously distributed species closely associated with specific habitats such as yelloweye is with a habitat-based abundance estimate where the densities observed within habitat strata are expanded by the total areal extent of habitat in the management unit (e.g., Nasby-Lucas et al. 2002; Yoklavich et al. 2007). In contrast to Southcentral Alaska, yelloweye catch limits in Southeast Alaska are tied to this type of habitat-based abundance estimate. The Alaska Department of Fish and Game (ADF&G) is using a Remotely Operated Vehicle (ROV) to estimate the density of yelloweye within habitat strata at several index sides along the outer coast of the Kenai Peninsula (Byerly et al. 2007, 2015). However, before a districtwide abundance estimate can be calculated, an estimate of the total area of suitable habitat in the district is required. The current project aimed to bridge this knowledge gap by producing a model for predicting potential yelloweye habitat from high-resolution bathymetry in Southcentral Alaska.

Young et al. (2010) successfully modeled the distribution of three species of rockfish — rosy (*S. rosaceus*), yellowtail (*S. flavidus*) and greenstriped (*S. elongatus*) — off California using a combination of submersible observations and multibeam echosounder (MBES) bathymetry. For each species they incorporated several depth derived terrain variables into a binomial logistic generalized linear model (GLM) to predict the probability of presence for that species. The current study used previously acquired MBES and ROV data to explore the feasibility of modeling yelloweye rockfish habitat in the Chiswell Island and Nuka Island study areas using an approach similar to that developed in California (Figure 1; Iampietro et al. 2005, 2008; Young et al. 2010).

Research Question

Can yelloweye habitat on the outer coast of the Kenai Peninsula be accurately modeled using high-resolution bathymetry? Primary objectives were:

1) Determine if yelloweye within the Chiswell and Nuka study areas are preferentially distributed across bathymetrically derived terrain variables.
2) Determine the most parsimonious combination of terrain variables for predicting the distribution of yelloweye habitat within the Chiswell study area.
3) Evaluate the accuracy of a GLM in predicting the distribution of yelloweye habitat within the Chiswell training area.

4) As a further test of portability and robustness, evaluate the performance of the Chiswell habitat model in the independent Nuka evaluation area.

2.2 METHODS

Study Areas

The Kenai Peninsula's outer coast is the ~200 km long span from Prince William Sound to Kachemak Bay (Figure 1). The coast is characterized by rugged, steeply incised glacial fjords and direct exposure to the Gulf of Alaska. For ADF&G commercial groundfish management purposes, the coast is defined as the North Gulf District, part of the Cook Inlet Management Area and bounded on the east by Cape Fairfield and Point Adam to the west (5 AAC 28.305).

Two different study areas along the outer coast were used in this analysis: the Chiswell Island study area and the Nuka Island study area (Figures 2 and 10). These were selected from amongst the four areas in the district where both MBES bathymetry and ROV rockfish surveys have been conducted. The Chiswell area was used for most of the variable selection and parametrization, while the Nuka area was reserved as a mostly independent testing area.

More precisely, the roles of the areas in the study were slightly more nuanced. Both areas were considered when selecting which scale of each type of terrain variable to include in the scope of the final variable selection process. However, to maintain the independence of the Nuka area for use as a test of the portability of the Chiswell model, the final variable selection from amongst the best scale of each type of terrain variable, was done using only the Chiswell area. Additionally, after testing the portability of the Chiswell model in the Nuka area, the GLM was reparametrized to the Nuka area for comparative purposes.

Chiswell Island

The ~17 by 28 km (161 km^2) Chiswell Island study area is located ~50 km southwest of Seward (Figures 1 and 2). The Chiswell Islands are granitic and, typical of the outer coast, contain numerous steep rocky walls and submerged rock piles (Wilson and Hults 2012). The depth within the study area ranged from 0 to 303 m, but only depths between 15 and 150 m were used in the analysis because only this depth range was surveyed with the ROV.

Nuka Island

The Nuka Island area is ~10 by 20 km (96 km^2), ~50 km west of the Chiswell area and ~ 60 km ESE of Homer (Figures 1 and 10). In contrast to the granitic bedrock of the Chiswell area, the bedrock in the Nuka area is metasedimentary. The study area contains areas of relatively shallow rocky relief separated by deep roughly parallel mud and sand filled troughs. The depth ranged from 0 to 250 m, but similar to the Chiswell area, areas shallower than 15 m and deeper than 150 m were not surveyed by the ROV and were excluded from the analysis.

Data Acquisition

All field sampling was completed prior to and independent from the current study.

ROV Video Surveys

ADF&G surveyed the Chiswell Islands for rockfish using a Deep Ocean Engineering, Phantom HD 2+2, ROV in 2004 and 2005 (Byerly et al. 2015). ROV position was determined using a Tracklink 1500MA Ultra Short Baseline (USBL) acoustic tracking system coupled to dGPS enabled Trimble AG132 receiver, Furuno SC-60 GPS compass and Applied Geomechanics, MD900-TW pitch/roll sensor. Approximately 69 transects, each 500 m long (~29 km in total), were surveyed with video. Yelloweye were observed at 164 points along these transects.

The Nuka ROV survey was completed in 2009 using the same equipment as was used in the Chiswell area except that a Kongsberg MRUD replaced the pitch/roll sensor. Approximately 82 transects, each 300 m long (~25 km in total), were surveyed. Yelloweye were observed at 169 points.

Bathymetric Surveys

The Chiswell bathymetry was compiled from two separate hydrographic surveys. The area north of Lone Rock (59^{o} 34.18’N) was surveyed by NOAA in 2000 using a Reson Seabat 8101 (240 kHz) MBES integrated with an Applanix POS/MV pitch/roll sensor and CSI MBX-3 dGPS receiver (data available://www.ngdc.noaa.gov). The area south of Lone rock was surveyed by Golder Associates, Inc. under ADF&G contract in 2006 using a Reson 8124 (600 kHz) MBES integrated with a pitch/roll sensor and Trimble Ag 132 dGPS receiver (Byerly et al. 2007). A digital elevation model (DEM) with 3 m horizontal resolution was mosaicked from these multibeam data.

The Nuka area was surveyed by ADF&G and Terrasond, Inc. in 2008, using a Reson Seabat 7125 (400 kHz) MBES, Applanix POS/MV pitch/roll sensor, and base station corrected GPS using Trimble 5700 receivers. A 3 m DEM was created from these survey data.

Analysis

Terrain Variables

Four types of terrain variables were derived from the depth rasters: Bathymetric position index (BPI), rugosity, slope, and distance–to-rock (DTR). All terrain variables related to the surface morphology of the seafloor; backscatter information from the MBES surveys was not included. A variety of scales were considered for each type of terrain variable, because fish associate with the seafloor at a variety of scales (Wilson et al. 2007; Anderson and Yoklavich

2007; Monk et al. 2011). BPI, rugosity, and DTR were each calculated at four different scales, corresponding to different sizes of neighborhoods used to calculate each of the metrics for a given cell (Table 1; Figures 3–7,11–15). Since depth and slope can be calculated without consideration of surrounding cells, only one scale was considered. The BPI and rugosity variables were calculated from the DEM using the Benthic Terrain Modeler (Wright et al. 2005).

Rugosity was calculated as the vector rugosity measure (VRM) and is a metric of the variance in three-dimensional orientation of vectors orthogonal to the surface of the cells (Sappington et al. 2007).

BPI is the difference in depth between a given cell and the mean depth of the cells in the surrounding neighborhood. It is used to distinguish ridgetops which have positive BPI values from valley bottoms which have negative BPI (Weiss 2001). A BPI value near 0 may be either nearly flat or midslope.

DTR was calculated as the Euclidean distance (m) to the nearest cell with a VRM value greater than a threshold value of 0.001 for DTR 7, 5 and 3, and 0.020 for DTR 21. Young et al. (2010) used a VRM threshold of 0.001 to distinguish soft sediment from rock. The 0.001 value, while somewhat arbitrary, appeared reasonable within both of the current study areas for the three finer scales of DTR. For DTR 21 however, the VRM threshold was increased to 0.020 because this better distinguished rocky areas from soft sediment.

Presence and Absence Points

A split sample method was used with 70% of the presence points applied to fit the model and the remaining 30% reserved to evaluate the accuracy of the model, except in the case of the Chiswell model being applied to the Nuka area. The latter case allowed all of the Nuka presence and absence points to be used in the accuracy assessment, because none of these points were used to fit the Chiswell model.

Ecological Niche Factor Analysis (ENFA)

Selecting absence points was more complex than presence points owing to imperfect detectability and false absences. To reduce the number of false absences, absence points were only selected from areas along transects that were identified by a preliminary ENFA as poor habitat, following Young et al.'s (2010) adaptation of the Engler et al. (2004) method of selecting pseudo-absences.

Ecological niche factor analysis (ENFA) is a method of modeling habitat distributions that does not require absence points. The method compares the n-dimensional space occupied by the species along n-environmental gradients to the multidimensional characteristics of the background or greater study area. This approach is similar to other multidimensional variable reduction techniques, such as principle component analysis (PCA), in combining multiple collinear predictor variables into a few 'super' variables or factors that account for the majority of the variation in the environmental data based on eigenvectors of predictor variable covariance matrices. However, unlike PCA where the factors are oriented orthogonal to one another, in ENFA the factors are constructed such that they are given easily interpreted ecological meaning. In ENFA, the first factor is termed the *marginality factor* which captures how different the occupied niche is from the totality of available environmental conditions. Subsequent factors are *specialization factors* which describe the breadth of the occupied niche.

ENFA's chief advantage over more traditional presence/absence habitat modeling techniques such as GLMs and GAMs is in avoiding the problem of false absences by relying only on presence points. The main disadvantage of ENFA is a tendency to overestimate the amount of suitable habitat (Engler et al. 2004).

As part of the ENFA, in addition to the marginality and specialization *factors*, overall marginality and specialization *values* were calculated. Marginality is a measure of how different the mean of the species frequency distribution (μ_S) across an environmental gradient is from the global or greater study area mean (μ_G), standardized by the standard deviation of the global distribution (σ_G) (Hirzel et al. 2002):

$$M = \frac{|\mu_G - \mu_S|}{1.96\sigma_G} \qquad (1)$$

Specialization is defined as the ratio of the standard deviation of the global distribution (σ_G) to the standard deviation (σ_S) of the focal species:

$$S = \frac{\sigma_G}{\sigma_S} \qquad (2)$$

In practice, both marginality and specialization are calculated over multiple dimensions; the univariate definitions presented above are for conceptual explanatory purposes. For most species, marginality ranges from 0 to 1, with large values indicating a large difference in conditions between where the species is found and the average in the study area. The raw specialization value is somewhat difficult to interpret since it ranges from 1 to ∞, so is often expressed as it inverse, tolerance. Tolerance ranges from 0 to 1, with 0 indicating a very specialized or stenoecious species, and 1 indicating a species tolerant to a wide variety of environments.

The ENFA in this study used the Biomapper version 4.0 software (Hirzel et al. 2007). All environmental rasters as well as the training set of presence points were converted to the IDRISI RST format required by Biomapper, while taking care to properly mask and co-register the layers so that they covered the exact same extent and all cells were perfectly aligned.

All environmental layers were normalized with the Box-Cox transformation (Box and Cox 1964). The Box-Cox transformation was used for all variables except where the Box-Cox transformed version caused terminal errors in the ENFA algorithm (due to discontinuous or very large values), in which case the raw, non Box-Cox transformed raster was used, following Hirzel et al. (2002). Although normality is theoretically desirable for extracting factors based on eigenvectors, empirically the ENFA algorithm is fairly robust to non-normality (Hirzel et al. 2002). For several layers, both the Box-Cox transformation and the raw variable caused terminal errors. These variables were excluded from the analysis. The broken stick method, with extreme optima, the harmonic mean algorithm, and 10 cross validations were used for both areas.

To convert the continuous habitat suitability raster from the ENFA (range 0 to 100, with higher values being more suitable) to a binomial suitable/unsuitable map, a habitat suitability score threshold of 3 was used for Chiswell and 12 for Nuka. These values were chosen such that 95% of training presence points were classified as suitable habitat.

Although Engler et al. (2004) created pseudo-absences by selecting points from among *all areas* where the organism was not detected, the surveyed transects within the current study areas were extensive enough that pseudo-absences were selected *only from areas that were surveyed* with the ROV and where yelloweye were not detected, following the methods of Young et al. (2010). Along this subset of the transects, the absence points were selected randomly. As with the presence points, 70% of the absence points in the Chiswell area were used to fit the model while the remaining 30% were reserved for an accuracy assessment.

Three performance indices were calculated to evaluate the habitat suitability score output from the ENFA (Hirzel et al. 2006). The absolute validation index ($0 < \text{AVI} < 1$) is the proportion of presence points with a suitability score > 50 and indicates how well the model discriminates highly suitable from unsuitable areas. To account for chance agreement, the contrast validation index (0 < CVI < AVI) was calculated by subtracting the AVI expected from a null model that would predict suitability at random. The Boyce Index is less dependent on a particular threshold than AVI and CVI, and can range from -1 to 1, with 0 expected from a chance model and 1 a perfect model.

Variable Selection

The significance of each type of terrain variable at each scale for each study area in predicting yelloweye presence or absence was determined using simple logistic regression and the Wald test of significance. Because a local optimum was suspected for depth and BPI, a quadratic transformation of each of these variables was included.

The predictive power of the different scales of terrain variables were ranked for each type of terrain variable within each study area based on differences in AIC scores (Burnham and Anderson 2004). Collinearity among scales of a given type of terrain variable were examined with correlograms based on Pearson's correlation coefficient. Because most scales of a given type of variable were correlated, and because including multiple collinear 'independent' variables in the same model can cause overfitting, exaggerate significance, and even reverse the sign of a coefficient, only the most predictive scale(s) of each type of variable was included in the scope of the final variable selection process.

Although it is common practice to include the linear term with a quadratic response term, so as not to overly constrain the shape of the response curve, exploratory plots of BPI30 vs. yelloweye presence/absence were relatively symmetric about the y-axis, so the linear term was excluded.

Collinearities among the best scales of each type of predictor variable were also examined with correlograms.

The final variable selection involved a forward stepping AIC analysis, in which the variables are added one at a time and the resulting AIC scores are compared, using the MASS package in R version 3.1.0 (Venables and Ripley 2010; R Core Team 2014). Although both study areas informed the choice of the best scale of each type of terrain variable, in an effort to maintain the independence of the Nuka area as a test of the portability of the Chiswell model, the final variable selection — from among the best scale of each type of variable — used only the Chiswell data.

Generalized Linear Model (GLM)

The final habitat suitability model took the form of GLM using a binomial logistic link function:

$$Logit(P) = X_1B_1 + X_2B_2 \ldots X_iB_i + \alpha \qquad (3)$$

where P is the probability of suitable yelloweye habitat in a given cell, X_i is the value of terrain variable i in that cell, B_i is the coefficient of that terrain variable, and α is an intercept. *Logit* is the logistic link function. It both linearizes binomial logistic data and constrains the probability between 0 and 1:

$$Logit(P) = ln\left(\frac{P}{1-P}\right) \qquad (4)$$

The GLM was fit using maximum likelihood estimation, and was parametrized twice, to create two versions of the GLM. First the GLM was fit to the Chiswell area, which was the focus of this study. After the accuracy of the Chiswell GLM was evaluated — both within the Chiswell area, and then in the Nuka area — the model was refit to the Nuka area and reevaluated solely in the Nuka area to compare changes in performance and parameter weighting.

Accuracy Assessment

The accuracy of each of the models was evaluated by producing confusion matrices and calculating the percentage of suitable points correctly classified as suitable and percentage of unsuitable points correctly classified as unsuitable. Overall accuracy was calculated as the percentage of all the ground truth points correctly classified. The ground truth points were the set of suitable and unsuitable habitat points based on the ROV observations. To more closely examine the accuracies of the individual classes (suitable and unsuitable), producer and user accuracies were calculated. These widely used measures of remotely sensed classification accuracy differ in their denominators. Producer's accuracy is the percentage of all the pixels assigned to a particular class that were classified correctly, while user's accuracy is the percentage of all the ground truth points of a particular class that were classified correctly. Sensitivity is the producer's accuracy for presence points, while specificity is the producer's accuracy for absence points (Fielding and Bell 1997).

Additionally, Cohen's Kappa was calculated for each model using the irr package (Cohen 1960; Gamer et al. 2012). Like percent agreement, Cohen's Kappa is based on a confusion matrix created using a fixed threshold, but is a more stringent test of the performance of a classification model because it accounts for chance agreement.

Finally, a receiver operator characteristics (ROC) analysis was completed for each of the various model and study area combinations using the ROCR package (Fielding and Bell 1997; Sing et al. 2007). ROC curves were plotted and the area-under-the-curve (AUC) scores were calculated for each model and area. ROC plots are created by plotting the true positive fraction (sensitivity) against the false positive fraction (1 - specificity) at various thresholds. Possible AUC scores range from 0 to 1, with 0.5 being expected from a completely random classification and 1.0 indicating a perfect classification with no false positives. The AUC is the probability that a randomly chosen suitable point would have a higher probability of being suitable than a randomly chosen unsuitable point. ROC curves are useful for evaluating the performance of classification models that output continuous responses, because unlike the confusion matrix based measures, they do not require that the response first be binomially reduced (Pearce and Ferrier 2000). Thus, they evaluate the performance of a classification model independent of any specific threshold. The ROC plots were also used to select appropriate thresholds to distinguish suitable from unsuitable habitat.

All three of these performance metrics (percent agreement, Kappa, and AUC) were calculated for: (1) the Chiswell model against the reserved validation set of the Chiswell presence and absence points; (2) the Chiswell model applied to the Nuka area using all of the Nuka points; and (3) the Nuka model applied to the Nuka area using the reserved validation points.

2.3 RESULTS

Distributions Across Univariate Gradients

Yelloweye presence was significantly related to each scale of each of the investigated terrain variables (simple logistic regression; Wald test of significance; $p < 0.001$) (Table 2). Although the linear versions of BPI30 for both areas and BPI60 for the Chiswell area were not significant predictors of yelloweye presence, the quadratic versions of both of these variables were significant, indicating dome-shaped responses, or local rather than extreme optima. Specifically, yelloweye were observed more: in (VRM) and near (DTR) rugose areas; steep areas, shallow areas; areas with positive large scale BPI; and areas of either positive or negative, but not neutral, small scale BPI (Figures 24 and 25).

Variable Selection

For each type of terrain variable, all scales were strongly correlated (Pearson's correlation coefficient > 0.5), except the smallest scale of BPI, BPI30, was only weakly correlated with the largest scale, BPI240 ($r < 0.45$) (Figures 19–21).

A scale factor of 7 was chosen as the best scale of VRM for inclusion in the scope of the final variable selection process, based on ΔAIC values of the single variable models (VRM7; Table 2). For simplicity and to avoid relying on rugosity calculated at two different scales, DTR7 was included in the final scope because this was the DTR scale corresponding to the best VRM scale (VRM7), even though DTR3 and 5 were stronger predictors (Table 2). The two most predictive scales of BPI were the linear version of BPI240 and the quadratic version of BPI30. The quadratic and linear version of the depth term had similar predictive power, so both were considered in the scope of the final stepwise AIC variable selection.

To summarize, the scope of variables considered in the final stepwise AIC variable selection process were VRM7, BPI240, $BPI30^2$, DTR7, Depth, $Depth^2$, and Slope (Figures 22-25). This was determined by first examining collinearity among various scales within each type of terrain variable, then selecting the best weakly-correlated scale(s) of variable(s) from each type, based on AIC scores for the univariate models.

The stepwise AIC process found the most parsimonious model for suitable yelloweye habitat in the Chiswell area included VRM7, DTR7, Slope and BPI240 (Table 3).

The ROC curve for the Chiswell area suggested a probability value of 0.5 as the best threshold for distinguishing unsuitable from suitable habitat (Figure 26). A threshold of 0.5 to 0.7 is often used for these types of GLM habitat models (Hirzel and Guisan 2002).

Accuracy Assessment

Chiswell GLM in Chiswell Area

Using a probability threshold of 0.5, the GLM fit to the Chiswell training points evaluated against the Chiswell validation points (n = 100) yielded an overall accuracy of 96% (Table 4; Figure 9). Both the producer's and user's accuracies for both presence and absence were also all 96%, yielding a significant ($p < 0.001$) Cohen's Kappa of 0.92. A Kappa value > 0.75 indicates "excellent agreement" (Landis and Koch 1977). The AUC was 0.997, with AUC > 0.9 indicating "outstanding" discrimination (Hosmer and Lemeshow 2004).

Chiswell GLM in Nuka Area

When the GLM as parametrized in the Chiswell area was applied to the Nuka area and evaluated against the entire set of presence and absence points in the Nuka area (n = 332), the overall accuracy dropped to 82.5%, comprised of a producer's accuracy for presence points of 95.7% and 69.3% for absence (Table 5; Figure 17). Cohen's Kappa for this classification was significant ($p < 0.001$) at 0.65. A Kappa value between 0.40 and 0.75 has been interpreted as "good agreement" (Landis and Koch 1977). The AUC was 0.952.

Nuka GLM in Nuka Area

When the GLM was reparametrized to the Nuka area, the accuracy of the model evaluated against the validation set of Nuka points, while retaining the same set of four predictor variables, increased as compared to the GLM fit to the Chiswell area (Tables 5 and 6; Figure 18). The overall accuracy increased to 89.0% comprised of a producer's accuracy of 88.0% for presence and 90.0% for absence. Cohen's Kappa increased to 0.78. In contrast to the accuracy metrics based on the fixed threshold, the threshold-independent AUC of the reparametrized Nuka

GLM evaluated against the validation Nuka points was very similar (AUC = 0.953) to the AUC of the Chiswell GLM tested against the entire set of Nuka presence and absence points..

ENFA

In both the Chiswell and Nuka areas, the marginality values (2.25 and 1.81 respectively) indicated that the terrain where yelloweye were observed was much different than the average terrain in each study areas (Tables 7 and 8). The tolerance values (0.52 and 0.58) indicated moderate specialization. The coefficients of the marginality factor in both areas indicated that yelloweye where observed in more rugose, near rugose, steeper and shallower areas than the average in each area. The marginality and specialization can be seen graphically by comparing the means and dispersion of frequency distributions of yelloweye occurrence relative to the greater study areas along the marginality and 1st specialization factors (Figures 27 and 28).

The composition of the marginality factor was nearly identical between areas, comprised mostly of VRM21 and with the ranked relative contribution of the individual variables identical except that the ranking of BPI60 and BPI240 was reversed (Tables 7 and 8). The specialization factors were comprised substantially of DTR in both areas. However the remaining composition of the specialization factors differed between areas, primarily in that BPI was more important in the Nuka area. The marginality factor combined with the first 3 specialization factors accounted for > 75% of the information in the training set of presence points in each area. Finally, the percentage of information accounted for by each factor was similar between areas.

As measures of performance, in the Chiswell area, the AVI (0.50), CVI (0.43) and Boyce index (0.64) all indicate the habitat suitability score from the ENFA was a good discriminator of suitable from unsuitable habitat. In Nuka area the AVI (0.30), CVI (0.30) and Boyce Index (0.44) indicate fair discrimination.

2.4 DISCUSSION

This study demonstrated that the distribution of yelloweye habitat on the outer coast of Alaska's Kenai Peninsula can be modeled with reasonable accuracy using several terrain variables derived from high-resolution MBES bathymetry.

Specifically, to revisit the primary objectives: (1) The distribution of yelloweye habitat was significantly related to each of the investigated terrain variables. (2) The most parsimonious combination of predictors for yelloweye habitat in the Chiswell area included a moderate scale of (i) rugosity and (ii) distance-to-rock, (iii) a broad scale BPI, and (iv) slope. (3) A GLM combining these variables was an excellent predictor of yelloweye habitat in the Chiswell training area. (4) This habitat model was fairly robust across study areas.

Comparison to Previously Published Models

A previous study to predict presence/absence of rosy, yellowtail, and greenstriped rockfish in the Cordel Bank Marine Sanctuary (CBMS) off California reported overall accuracies of 96, 92 and 92% with Kappas of 0.89, 0.71, 0.62, respectively (Iampietro et al. 2008; Young et al. 2010). These accuracies are similar to the 96% overall accuracy and Kappa of 0.92 for the Chiswell model when evaluated in the area it was fit.

The accuracy of the Chiswell model tested in the independent Nuka area was also similar to the previously published accuracy of one of the two CBMS models when evaluated in an independent study area. Iampietro et al. (2008) found the CBMS model for greenstriped to be 71% accurate (Kappa = 0.42) when evaluated at the independent Del Monte shalebeds (DMSB) off California. In contrast however, their CBMS model for rosy was unsuccessful at predicting habitat in the DMSB, classifying the entire DMSB study area as habitat. The authors attributed the poor performance of the rosy model in the DMSB to the different depth ranges of the study areas and the influence of depth in the rosy model. For comparison, when the Chiswell model was applied to the Nuka area the accuracy was 82.5% (Kappa = 0.65). To summarize, the Chiswell model performed slightly better than the best of the Californian models, both when evaluated within the area it was fit and when fit to the independent Nuka area.

One main difference among studies was the inclusion of depth as an explanatory variable in the California models; depth was considered for the Chiswell and Nuka models but excluded by the stepwise AIC process. This could explain why the Chiswell model was more portable across areas than the California models. While demersal rockfishes do exhibit preferred depth ranges (Richards 1986; Johnson et al. 2003; Rooper 2008), it could be that the rosy habitat preference observed by Young et al. (2010) was more directly linked to another variable closely correlated with depth, such as the depth distribution of rugose rock outcrops. Perhaps, since depth was only related to the distribution of rosy in CBMS tangentially, the apparent depth preference observed there, did not hold true in the DMSB.

Monk et al. (2012) reported AUCs ranging from 0.54 to 0.96 for GLMs predicating the distribution of nine reef fishes off Australia based on several MBES terrain variables (including rugosity, BPI, depth, and distance-to-reef). The AUC's of their best performing models compare similarly to the AUC's of both the Nuka and Chiswell GLMs.

ROC Analysis

The ROC analysis indicated excellent performance of the GLM habitat models developed for the North Gulf District, both within the areas they were fit and when applied to different study areas. As expected, the Chiswell model performed better in the Chiswell area where it was fit, than in the independent Nuka testing area (AUC = 0.987 vs 0.952).

Unexpectedly, refitting the GLM to the Nuka area did not substantially improve the AUC over that from the Chiswell model (0.952 for Chiswell model in Nuka area vs. 0.953 for Nuka in Nuka). However, this is confounded by the different sets of validation points used. All Nuka presence/absence points were used to evaluate the Chiswell model applied to the Nuka area since none of these were used in fitting the model, while the training points were excluded from the ROC evaluation of the GLM refit to the Nuka area. Although it is somewhat circular to evaluate the performance of a model using the same set of points used to fit it, the ROC plot for the Nuka model in the Nuka area using the training points is included as ancillary support of the earlier hypothesis that the unexpected lack of increase in AUC accompanying the refit of the GLM in the NUKA area likely reflects the different points used in the evaluation, and the relatively small sample size for the evaluation points. As expected, when the model was refit to the Nuka Area and evaluated using the validation points, the AUC increased (0.960), similar to that of the Chiswell model when evaluated using the Chiswell validation points (AUC = 0.987).

Direct vs. Indirect Environmental Variables in Habitat Models

It is important to acknowledge that none of the investigated terrain variables are 'directly' driving the distribution of yelloweye. Guisan and Zimmermann (2000) discussed the types of variables used in habitat models. Ideally, habitat models rely on what they denoted as *resource* or *direct* variables which both have physiological significance to the focal species (e.g., prey density, water temperature, and salinity). In contrast, the less desirable *indirect* variables (e.g. BPI, VRM, and slope) do not present the same physiological significance. Unfortunately, resource and direct variables are the most expensive and difficult to obtain over the large areas required by habitat models, often requiring in situ measurements. Indirect variables in contrast can often be remotely sensed. Consequently many habitat models, including the current study, are often obliged to rely on the less desirable indirect variables. The main disadvantage of relying on indirect variables as opposed to direct or resources variables is that because they are, by definition, not fundamentally directly driving the distribution of the species, a model relying on indirect variables will likely have limited portability and robustness.

All of the terrain (indirect) variables used in the present habitat model likely gain their significant relationship with yelloweye distribution only indirectly through their collinearity with either the resource variable availability of prey, or the direct variable availability of refuge. Food resources are concentrated near rock outcroppings by currents. The complex three-dimensional complexity of rugose rocky areas increases the availability of crevices for use as refuge from predation and enhanced ambush feeding opportunities (Yoklavich et al. 1999; Greene et al. 2011). The void to clast ratio of the substrate appears to be especially important to yelloweye distribution (O'Connell and Carlile 1993). BPI probably gains most of its importance as an indicator of positive topography capable of deflecting currents and concentrating prey. The rugosity based VRM and DTR variables on the other hand probably gain most of their importance from their relationship to the availability of refuge. Slope may be important because it is related to both prey and refuge availability.

Critiques

The most substantial critique of the current study is its accuracy assessment. Since the absence points used in the assessment were only selected from those areas classified by the ENFA as unsuitable habitat, to some degree, the accuracy assessment is comparing the results of the ENFA to the GLM. This critique applies to the published models of Young et al. (2010) as well. The problem is rooted in the unreliable absence issue, common to all presence/absence habitat models. Selecting the absence points based on the ENFA was done in good faith, in an effort to reduce false absences. Alternatively, if the absence points were not filtered by the ENFA, false absences likely would be selected which would induce their own biases in the accuracy assessment. The problem of unreliable absences will plague any presence/absence habitat model.

Kéry (2010) describes specific problems caused by imperfect detectability including underestimation of habitat, and confusing covariates of probability of detection with covariates of probability of occurrence. A strong argument is provided for modeling species distribution with site occupancy models, where occupancy is modeled as the product of detection and occurrence. A site occupancy model was not used here, because of the need for repeat sampling. Also, site occupancy models do not ameliorate the more operative type of false absences in this study, those absences related to the relative rarity of yelloweye and the fine scale of the observation unit. It would be unreasonable to expect a relatively rare species such as yelloweye to occupy every 3 m cell of suitable habitat. The most promising approach to dealing with this type of false absence is through a presence-only type of model, such as the ENFA used in the first step of the current analysis.

Limitations

The biggest limitation for the real world application of the habitat model presented here to management is the model's reliance on MBES data. The most useful rockfish habitat model would be one capable of distinguishing habitats using only single beam bathymetry. Even though the yelloweye model developed here displays at least some degree of portability between study areas, its real world application is limited because multibeam data are only available for some, as yet relatively small, portions of the coast, whereas single beam data are available for the entire coast of Alaska. Realizing that complete coastwide full coverage multibeam data will not be achieved for a long time (despite an annual budget of $12 million), Elvenes et al. (2014) investigated the feasibility of modeling the distribution of surficial sediment and benthic biotopes in Norway using single beam data and compared the resultant maps to those obtained from multibeam sonar. Results were encouraging, with the single beam data yielding habitat maps very similar to maps from multibeam data. However, the data density of the single beam bathymetry appears to be greater than what is available for the North Gulf District, and mapping was also at a coarser scale. The best available single beam bathymetry readily available for the central Gulf of Alaska is Zimmermann and Prescott's (2015) layer (100 m horizontal resolution) based on the digitized and corrected smooth sheet soundings used to create NOAA navigational charts. Elvenes et al. (2014) on the other hand used Olex-derived single beam bathymetry in a heavily trafficked area. Olex is a crowdsource system for compiling and sharing bathymetry collected by ordinary (non survey) vessels during everyday operations. Although some vessels do use the Olex system in Alaska, the participation rate is likely greater in Norway where the system was developed. However, Olex bathymetry in the North Gulf District should be investigated more thoroughly, specifically as a potential data source for a habitat model. The Kenai Fjord Tours fleet of commercial tour boats use the system, so perhaps Olex would provide a valuable bathymetric data source, at least for some of the more heavily trafficked areas.

When relying on rugosity to predict probability of occurrence, one must be attentive to survey data quality and the smoothing algorithms applied to it during post processing. Of all the investigated terrain variables, rugosity is likely the most negatively affected by poor bathymetric survey data quality. The bathymetry in the Nuka area had more survey artifacts such as roll artifacts, which appear as lines perpendicular to the transect orientation, and in general was noisier with many points of either null or erroneous data. These survey artifacts inflated the calculated rugosity, which in turn inflated the predicted probability of suitable habitat in those areas. Not surprisingly, when the GLM was refit to the Nuka area, the relative weight of VRM and DTR decreased while the other variables, especially BPI, increased. Apparently in areas with poor quality bathymetry, BPI gains importance as a predictor of habitat as compared to the rugosity-based VRM and DTR.

Applications

Despite the limitations inherent to its reliance on MBES data, the model presented here does have real world value to improving the management of DSR in Alaska. More specifically and foremost, the GLM could be used to classify both existing and anticipated MBES bathymetry into suitable and unsuitable DSR habitat.

While most of the existing MBES data in the North Gulf District have already been classified, large areas of unclassified MBES data exist in the adjacent Cook Inlet and Prince William Sound (PWS) districts. The one existing MBES dataset in the North Gulf District that has not yet been classified is the course grid spanning the western portion of the district (Figure 1). An algorithmic method as presented here could be used to classify these data, which will be key to interpreting the surrounding area where only single beam data are available.

Undoubtedly in the future, more of the North Gulf District will be surveyed with MBES. Collecting coastwide multibeam data has been identified as a priority of many nations (Elvenes et al. 2014). More locally, as evidence of the increasing availability of multibeam, the United States Geological Survey (USGS) recently signed a five-year cooperative agreement with ADF&G to jointly collect multibeam bathymetry along the Northern Gulf of Alaska. As part of this effort, 600 km^2 were surveyed during 2014 in the PWS district near Chenega and Cape Cleare, and 900 km^2 were surveyed in 2015 in the Southeast Region near Cape Spencer. None of these areas have yet been classified as suitable or unsuitable DSR habitat. The model presented here could be used to stratify these anticipated MBES data as they becomes available, thereby improving the habitat area estimates used in the Southeast Region based on the best available data, and towards providing an initial estimate of habitat in Central Region.

In addition to the MBES data that have not yet been classified, existing habitat delineations in multibeam areas could be revised using the algorithmic method presented here. Previous classifications involved either manual expert interpretation in the Southeast Region (Greene et al. 1999); or semianalytic methods, based on a combination of slope, rugosity, depth and manual interpretation in the Central Region. A purely objective, algorithmic classification would reduce potential bias and improve standardization across management areas.

ENFA

Although the ENFA was conducted primarily as a means of reducing false absences for use by the GLM and was not intended to be the focus of the current study, some comments about it are warranted. The habitat suitability model derived from the ENFA could conceivably be used as a stand-alone habitat model (e.g., Hirzel et al. 2001; Leverette 2005; Galparsoro et al. 2009; Monk et al. 2010, 2011). Indeed, the habitat suitability maps from the ENFA appear to do a reasonable job of classifying rock outcrops as suitable habitat and the flat areas as unsuitable (Figures 8 and 16), and the performance measures (AVI, CVI, and Boyce Index) obtained from it provide some measure of validity.

The main reasons the ENFA was not used as the primary habitat model in this study were: (1) I wanted to first test the methods developed for the CBMS and the DMSB (Iampietro et al. 2008; Young et al. 2010) as a baseline, before delving into the multitude of different modeling methods; (2) previous work warned that ENFA habitat models tend to be overly inclusive (Engler et al 2004); (3) evaluating the accuracy of presence-only models like ENFA is more complex than classic regression-based presence/absence models such as GLMs.

The ENFA for both the Chiswell and Nuka areas indicated that yelloweye are a highly marginal species, with the occupied niche dramatically different from the average conditions available in an area, and also a stenoecious species in regards to the investigated terrain variables. The strikingly similar composition between areas of the marginality factor, and also the specialization factors, indicate that the observed relationships between the distribution of yelloweye and each of the investigated terrain metrics is consistent between areas, thereby suggesting a general ecological relationship rather than statistical coincidence.

The Importance of Scale

The choice of scale is important to any habitat model. While the importance of pixel size (grain) used in the analysis is also well established, the focus here is on the importance of the size of the neighborhood used to calculate each of the individual terrain metrics (Wilson et al. 2007). Although all the single variables except the linear version of BPI30 were significant when considered independently, the relative predictive power of variables depended greatly on size of neighborhood used in the calculation, as evidenced by the large difference in AIC values among model configurations. Furthermore, the functional response varied depending on the scale of analysis. Particularly interesting is how BPI is monotonically related to yelloweye presence when calculated using a large neighborhood, yet when a small neighborhood is used the response curve becomes dome-shaped, with a local minimum centered about neutral BPI values of 0 (Figures 24 and 25). This indicates that when considered on a larger scale, yelloweye prefer to be up near the tops of broad swales and mounds, yet when considered at a finer scale, yelloweye are found both in the bottoms of small localized depression and on the tops of small localized ridges, but not as commonly on flat or midslope locations. The large scale BPI likely is effective at distinguishing large scale hard bottom areas of positive relief from soft bottom depressions, and the small scale BPI is probably more effective at pinpointing those smaller scale structurally complex areas, which manifest as both positive and negative topography. As a related alternate explanation, this could be also due to differences in how yelloweye settle (large scale choice) and in how they choose to forage (small scale choice).

For rugosity, the larger scales of VRM performed better than the smaller scales of VRM except that in the NUKA area, VRM21 (the largest scale considered) performed poorly. The converse is true for DTR, with the smaller scales generally performing better than the larger scales. This could be attributed to either ecology or survey positional inaccuracies. As an ecological explanation, perhaps yelloweye need not actually be in rugose areas so long as they are near rugose areas, with being near rugose areas captured best by both the large scale VRM, with its large effective search radius, and the small scale DTR which inherently buffers rugose areas. Alternatively, perhaps this theoretical disjunction between smaller scale rugose features and yelloweye presence was more related to positional imprecision associated with the ROV survey. The 3 m cell size certainly pushes the limit of, and likely often exceeds, the precision of the acoustic USBL tracking system used to locate the ROV.

For BPI, both the quadratic transformations of the small scale versions and the linear versions of the large scale BPIs performed well.

These findings that the value of terrain variables in predicting habitat depends on the scale of analysis (neighborhood size) are consistent with other marine benthic habitat modeling studies (Wilson et al. 2007; Galparsoro et al. 2009; Monk et al. 2011).

Distributions Across the Univariate Gradients

The relationship between yelloweye presence and each of the six best scales of the individual terrain variables were largely as expected and similar between study areas (Figures 24 and 25). The preference for shallow areas was not entirely anticipated and may be caused by collinearity between depth and some other more important driver of yelloweye distribution, e.g. the depth distribution of rugose rock outcroppings, as discussed earlier. For example, the relationship between depth and yelloweye distribution seen here may be indicative of the rugose rocky outcroppings tending to be in shallow areas, rather than depth itself being the operative driver of yelloweye distribution.

Future Research

Although the most important avenue for future research is investigating the feasibility of distinguishing rockfish habitat using only single beam data, if one were to remain reliant on multibeam data, the most promising way to improve the current model would be to incorporate the backscatter intensity as one of the independent variables. Acoustic characteristics, chiefly the intensity of the return sonar signal, have been widely demonstrated to be closely linked to the physical composition (via acoustic reflectivity or hardness) of the seafloor, which in turn is significantly related to yelloweye densities (O'Connell and Carlile 1994; Ferrini and Flood 2006; Brown and Blondel 2009; Parnum et al. 2009; Brown et al. 2011).

Other potential explanatory variables are modeled or measured bottom current velocities (especially in conjunction with aspect of the seafloor) — although these are likely to be of much coarser resolution than the terrain variables used here — an ocean exposure index, or additional terrain metrics such as curvature, complexity and aspect (Ardron 2002; Burrows et al. 2008; Rooper 2014; Zimmermann *In press*). Most recently, Zimmermann (*In press*) demonstrated how the substrate information interpolated from National Ocean Service (NOS) smooth sheets could be used in simplistic conditional habitat suitability maps for juvenile flatfish, including two study areas in the North Gulf District (Port Dick and Aialik Bay). Substrate point data on smooth sheets, while ~17 times more dense than what is found on final published navigational charts, is still probably too coarse to sufficiently delineate habitat on its own. However, perhaps an interpolated substrate layer would enhance a purely morphologic model, such as the one presented here, as an additional predictor variable.

In addition to the independent variables, the dependent variable (probability of suitable habitat) could also be improved by using acoustic tags to get more information on the relative amounts of time fish spend in various habitats. This type of resource use habitat modeling is increasingly being used for terrestrial animals (e.g., Beus 2010).

Finally, apart from the variables, alternatives to the framework of the model itself could be explored. Although GLMs are extremely popular in habit suitability modeling, use of GAMs has increased mostly because of their ability to accommodate a more diverse range of response surfaces (Guisan et al. 2002; Rooper et al. 2014; Sigler et al. 2015). Monk et al. (2012) found the choice of specific modeling technique (GAM, GLM, or MAXENT) did not considerably influence the distributions of nine demersal fishes predicted from multibeam variables. Instead they found the type of particular occurrence dataset used to be more influential, and echoed Kery's (2010) urge for care in interpreting the output of species distribution models that do not account for probability of detection. When Monk et al. (2010) compared a variety of presence-only modeling techniques (ENFA, MaxEnt, BIOCLIM, and DOMAIN) for five demersal fishes using MBES terrain variables, they found MaxEnt generally performed slightly better than ENFA based on Kappa and AUC.

Conclusion

This study demonstrated that yelloweye habitat can be modeled with reasonable accuracy using several terrain variables derived from high-resolution multibeam bathymetry. Furthermore, such a model displayed fair portability between areas within the North Gulf District. However, the application of such a model is limited simply because the model is entirely reliant on multibeam bathymetry and multibeam bathymetry is currently only available for certain portions of the coast. Therefore, the most imperative avenue for future research is investigating the feasibility of modeling yelloweye habitat using the less desirable but more widely available bathymetry from either NOS smooth sheets or Olex. Unfortunately, given the data density of these alternate bathymetry sources, the feasibility of modeling yelloweye habitat based purely on the surface morphology of these data is uncertain. The most promising approach to modeling yelloweye habitat in these areas with only crude depth information is by incorporating an interpolated substrate composition layer as an additional explanatory variable. The output from such a model, supplemented perhaps with buffered rocky features on smooth sheets, will undoubtedly be rough, but offers the best chance of providing an interim estimate of the areal extent of yelloweye habitat in the district, thereby bridging the knowledge gap introduced earlier necessary for achieving the ultimate goal of a districtwide abundance estimate of yelloweye. Such an interim estimate of habitat could be revised as the single beam data is supplanted with additional multibeam data anticipated in the future.

GENERAL DISCUSSION

The primary motivation for this project was the need for an areal expansion factor to use in a districtwide abundance estimate of yelloweye rockfish. Specifically, I explored whether yelloweye habitat can be accurately modeled using high-resolution bathymetry acquired using multibeam sonar, with validation through ROV observations. I concluded that yelloweye habitat can be accurately modeled using high-resolution bathymetry, and furthermore, such a model is fairly robust and portable between sites within the North Gulf District. However, given the current limited availability of multibeam bathymetry, a habitat model entirely reliant on these high-resolution data is not sufficient for deriving a districtwide estimate of habitat. Therefore, the most imperative avenue for future research is investigating the feasibility of modeling yelloweye habitat using the poorer quality but more widely available data from either the Olex crowdsourced compilation of single beam bathymetry, or the lead line and single beam bathymetry archived on NOS smooth sheets. In all likelihood, given the data density of these alternate bathymetric sources, a successful habitat model in these areas will likely require additional explanatory variables, most promisingly, a substrate composition layer interpolated from substrate point data on smooth sheets and other sources (e.g., Zimmermann *In press*).

In light of the uncertain feasibility and anticipated poor precision of habitat delineations based on this course alternative bathymetry, a deliberate discussion of how best to proceed with the overall management strategy for DSR in the Southcentral Region of Alaska is warranted. Rather than expand densities observed by the ROV up to an absolute estimate of abundance, maintaining the observed densities as a strictly relative measure of abundance may be best. After all, the ROV surveys will provide the same essential information signal, regardless of whatever particular areal expansion factor is used. Instead of scaling the densities up to an absolute abundance estimate based on a grossly imprecise estimate of the total areal extent of habitat, it may be best to simply maintain the ROV observations as density.

In situations with many false absences, such as the current study owing to the relative rarity of the species and small scale of observational unit, a presence-only modeling approach may be more appropriate than the presence/absence approach used here. Several methods of reducing false absences have been developed to accommodate presence/absence models. Here, I used Young et al's (2010) adaptation of the Engler (2004) method of reducing false absences based on a preliminary presence-only ENFA. The problem with using this two-step approach in situations where false absences are prevalent is that by filtering the absences heavily with the ENFA, then using those absences to validate the GLM, a potential circularity of logic is risked, wherein the output of the ENFA is used as truth to validate the GLM. The absences did need to be filtered somehow however. If they were not, false absences in both the training and validation set of absences would induce bias and reduce model performance. In situations like this, where heavy filtering is required, it may be best to adhere to a presence-only model. That way the problematic requirement for reliable absences is alleviated altogether. In contrast, in situations with more reliable absences owing to either a larger observational unit (e.g., groundfish trawl survey tows, Rooper et al. 2014; Sigler et al. 2015) or more ubiquitous species such as many plants, presence-absence modeling techniques such as GLMs and GAMs are appropriate and perform well.

For the presence-only step of my analysis I used ENFA, which is attractive because its output is so easily interpreted in ecological terms. The ENFA appeared to do a reasonable job of distinguishing rugose rocky areas from flat soft sediment areas, and its performance could certainly be fine-tuned if it was intended as the focus of a study. However, MaxEnt is the more popular profile technique used in recent literature, and has shown a slight performance advantage over ENFA when used to model the distribution of demersal fish based on terrain variables derived from MBES bathymetry (Monk et al. 2010). The problem with any of these presence-only techniques is that without absences, a comprehensive satisfactory evaluation of their performance remains elusive.

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TABLES

Table 1. Predictor variables and scales considered for the ENFAs and GLMs. In addition to these linear terms, quadratic terms for depth and all of the bathymetric position index (BPI) variables were considered, because local optima were suspected. No neighborhood size is provided for depth, slope or distance-to-rock (DTR), because these were calculated without consideration of surrounding cells. No inner radius is provided for vector ruggedness measure (VRM), because this is calculated using a square rather than annulus shaped neighborhood. Numbers in variable names correspond to radii in meters for BPI and diameters in cells for VRM. The numbers in the DTR names indicate which scale of VRM that DTR variable is based on. Dashes indicate not applicable.

Variable	Inner radius (cells)	Outer radius (cells)	Inner radius (m)	Outer radius (m)
Depth	-	-	-	-
Slope	-	-	-	-
BPI30	5	10	15	30
BPI60	15	20	45	60
BPI120	35	40	105	120
BPI240	75	80	225	240
VRM3	-	1	-	3
VRM5	-	2	-	6
VRM7	-	3	-	9
VRM21	-	10	-	30
DTR3	-	-	-	-
DTR5	-	-	-	-
DTR7	-	-	-	-
DTR21	-	-	-	-

Table 2. Performance of various scales of simple logistic regression models at predicting suitable yelloweye habitat ranked by AIC score within each type of terrain variable for both study areas. Significance of each univariate model is also included (Wald test ; * indicates p <0.001). Highlighted variables were considered in the scope of the final stepwise AIC variable selection process for the GLM.

	CHISWELL			NUKA		
	Scale	**ΔAIC**	**p**	**Scale**	**ΔAIC**	**p**
VRM	21	0.0	*	7	0	*
	7	30.3	*	5	8.3	*
	5	49.4	*	3	28.3	*
	3	82.8	*	21	56.9	*
BPI	60^2	0.0	*	240	0	*
	240	6.5	*	30^2	30.0	*
	30^2	20.6	*	120	36.3	*
	120^2	25.7	*	60^2	36.8	*
	240^2	46.3	*	240^2	40.2	*
	120	77.5	*	120^2	55.4	*
	60	102.7	0.009	60	89.0	*
	30	106.1	0.045	30	108.4	0.446
DTR	3	0.0	*	5	0	*
	5	6.3	*	3	1.2	*
	7	12.7	*	7	7.8	*
	21	35.7	*	21	61.2	*
Depth	3^2	0.0	*	3	0.0	*
	3	0.9	*	3^2	4.6	*
Slope	3	0.0	*	3	0.0	*

Table 3. Summary of the GLM fit to each of two study areas. Values in parenthesis are p values based on the Wald test.

Parameter	Chiswell Estimate		Nuka Estimate	
Intercept	-0.0842	(0.940)	-2.4380	(<0.001)***
DTR7	-0.0774	(0.004)**	-0.0271	(0.166)
Slope	0.1970	(0.005)**	0.1083	(0.041)*
VRM7	319.0483	(0.303)	295.6500	(0.004)**
BPI240	0.0649	(0.274)	0.1136	(0.003)**
AIC	73.4		125.2	
Null deviance	316.1		321.6	
Residual deviance	63.4		115.2	
n (observations)	228		232	

*** indicates $p < 0.001$
** indicates $p < 0.01$
* indicates $p < 0.05$

Table 4. Error matrix for the Chiswell GLM applied to the Chiswell area. The presence and absence points used in this accuracy assessment were independent from those used to the fit the model.

		OBSERVED		User's Accuracy
		Absent	Present	
PREDICTED	Absent	**48**	2	96.0%
	Present	2	**48**	96.0%
	Producer's Accuracy	96.0%	96.0%	**96.0%**

Kappa = 0.92

n = 100 observations

Table 5. Error matrix for the Chiswell GLM applied to the Nuka area. All presence and absence points from the Nuka area were used in the evaluation because none of these points were used to fit the model.

		OBSERVED		User's Accuracy
		Absent	Present	
PREDICTED	Absent	**115**	7	94.2%
	Present	51	**159**	75.7%
	Producer's Accuracy	69.3%	95.7%	**82.5%**

Kappa = 0.65

n = 332 observations

Table 6. Error matrix for the Nuka GLM applied to the Nuka area. The presence and absence points used in this accuracy assessment were independent from those used to the fit the model.

		OBSERVED		User's Accuracy
		Absent	Present	
PREDICTED	Absent	**45**	6	88.2%
	Present	5	**44**	89.8%
	Producer's Accuracy	90.0%	88.0%	**89.0%**

Kappa = 0.78

n = 100 observations

Table 7. Summary of the Chiswell ecological niche factor analysis (ENFA). The top row contains the percentage of information contained in the multivariate dataset accounted for by each of the four most important ecological factors. The cells bellow contain the coefficients for each individual terrain variables for each ecological factor. The variables are sorted by the absolute values of the marginality factor weighting with positive coefficients for the marginality factor indicating that yelloweye prefer locations with higher values than the mean value in the Chiswell study area. All variables were normalized with the Box-Cox transformation except for VRM21 which was not because extreme values caused a terminal error in the ENFA algorithm. VRM7, VRM5 and VRM3, and BPI30 also caused terminal errors in the algorithm because they were not continuous enough and were not included in the ENFA.

Terrain Variable	**Marginality Factor** (40%)	**Specialization Factor 1** (19%)	**Specialization Factor 2** (11%)	**Specialization Factor 3** (8%)
VRM21	0.449	-0.042	-0.013	0.002
DTR3-box	-0.373	-0.035	-0.817	-0.164
DTR21-box	-0.368	-0.120	-0.113	-0.253
DTR5-box	-0.364	-0.630	0.449	0.861
DTR7-box	-0.360	0.693	0.179	-0.401
Slope-box	0.259	-0.264	-0.114	0.034
Depth-box	0.198	0.176	-0.199	0.053
BPI60-box	0.179	0.000	-0.013	0.016
BPI240-box	-0.059	0.047	-0.113	-0.048
BPI120-box	0.055	0.025	0.021	-0.004

Marginality: 2.256
Specialization: 1.921
Tolerance: 0.520

Table 8. Summary of the Nuka ecological niche factor analysis (ENFA). The top row contains the percentage of information contained in the multivariate dataset accounted for by each of the four most important ecological factors. The cells bellow contain the coefficients for each of individual terrain variables for each ecological factor. The variables are sorted by the absolute values of the marginality factor weighting with positive coefficients for the marginality factor indicating that yelloweye prefer locations with higher values than the mean value in the Nuka study area. All variables were normalized with the Box-Cox transformation except for VRM21 which was not because extreme values caused a terminal error in the ENFA algorithm. VRM7, VRM5 and VRM3, and BPI30 also caused terminal errors in the algorithm because they were not continuous enough and were not included in the ENFA.

Terrain Variable	**Marginality Factor** (33%)	**Specialization Factor 1** (25%)	**Specialization Factor 2** (10%)	**Specialization Factor 3** (8%)
VRM21	0.544	0.006	-0.101	0.055
DTR3-box	-0.334	0.256	-0.107	-0.202
DTR21-box	-0.332	-0.281	0.439	0.706
DTR5-box	-0.332	-0.011	0.258	0.086
DTR7-box	-0.324	0.470	-0.535	-0.458
Slope-box	0.279	-0.035	-0.183	-0.111
Depth-box	0.216	0.236	0.421	-0.080
BPI240-box	-0.181	-0.715	0.304	-0.362
BPI60-box	0.123	-0.050	0.134	-0.163
BPI120-box	-0.071	-0.209	-0.273	0.225

Marginality: 1.816
Specialization: 1.725
Tolerance: 0.579

FIGURES

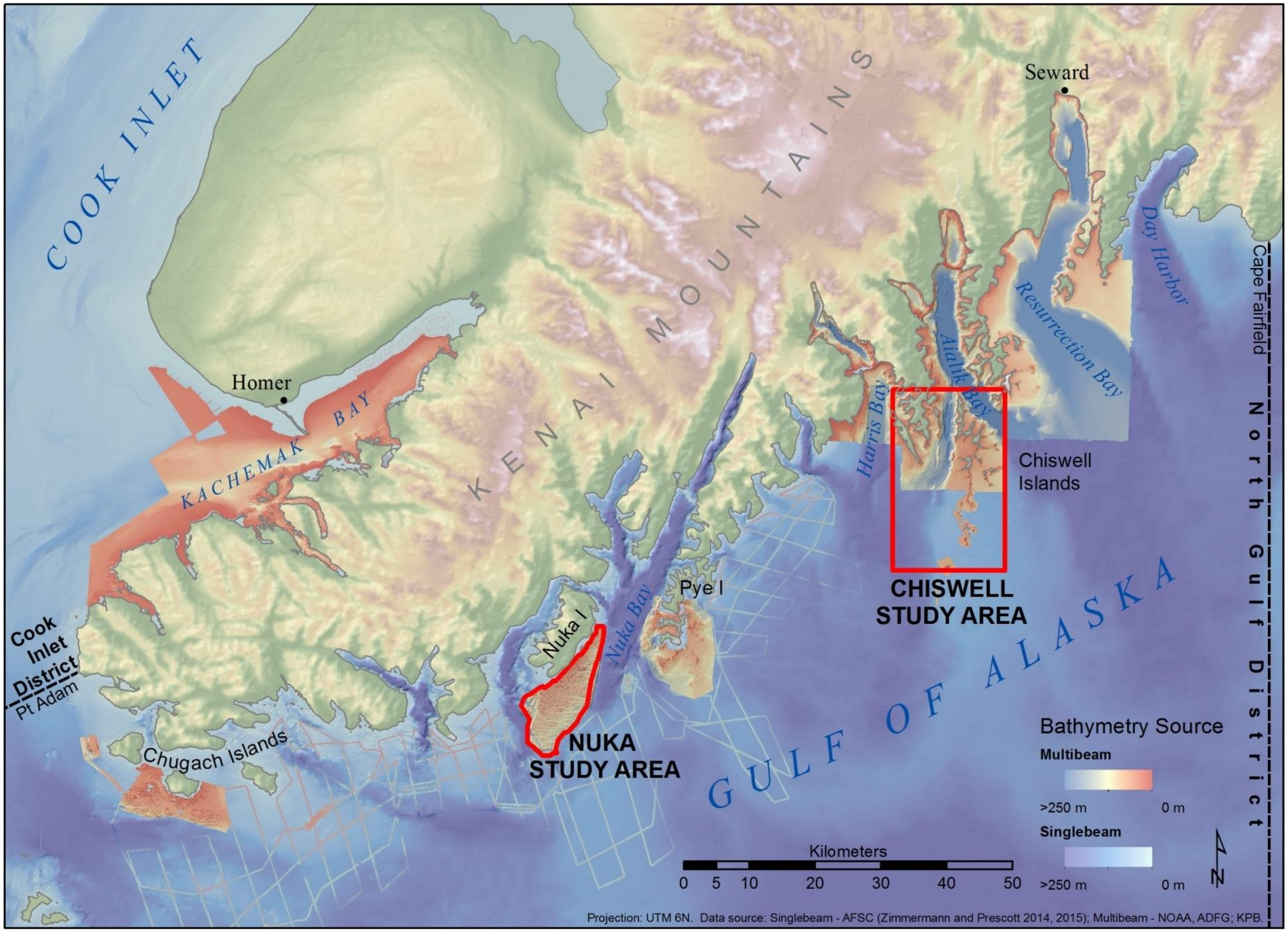

Figure 1. Location of the two study areas within the North Gulf ADF&G commercial groundfish management district and the best available bathymetry. Reddish bathymetry was surveyed with multibeam sonar while the blue data are from smooth sheets.

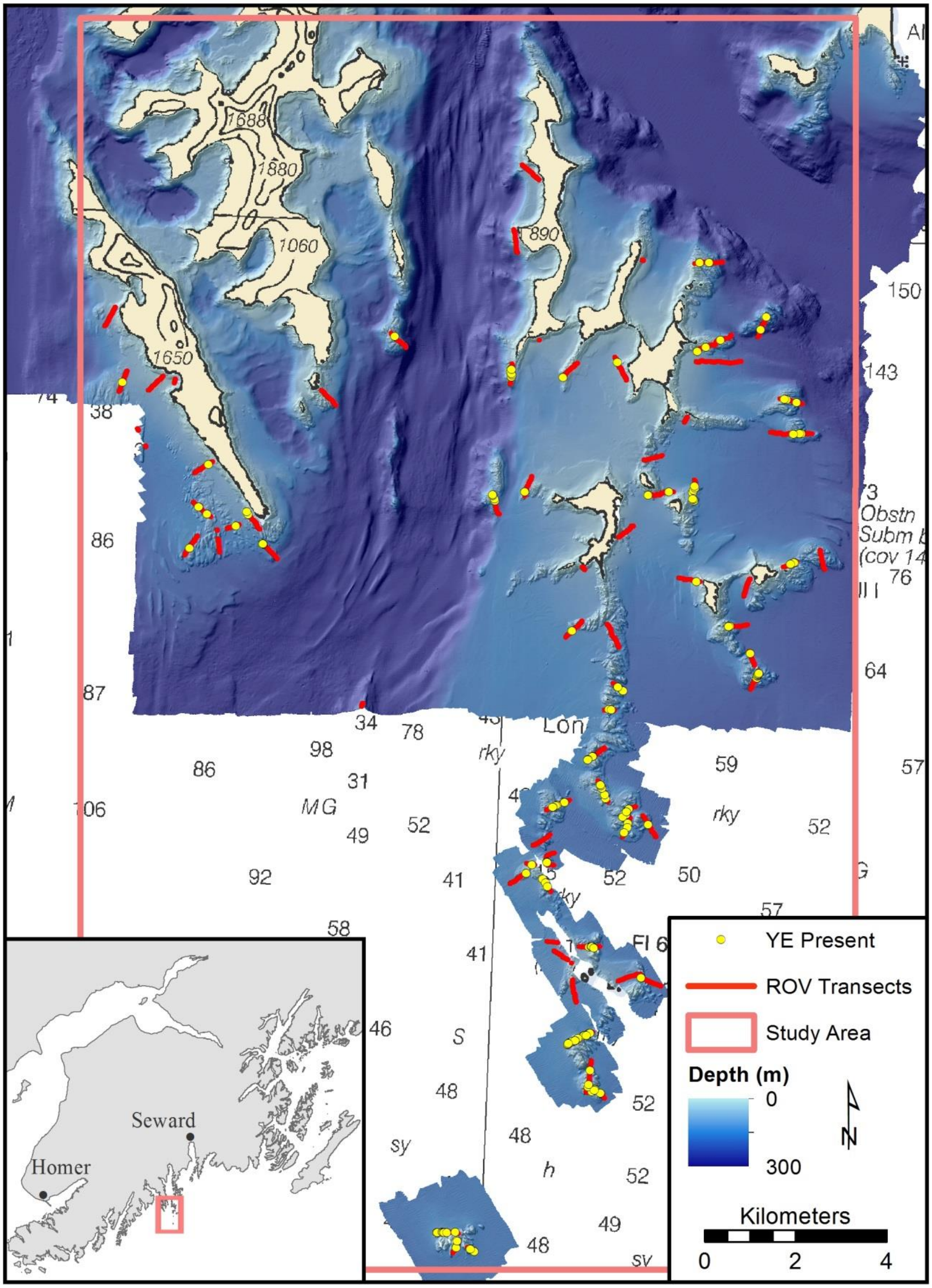

Figure 2. Chiswell Island Study area. Red lines are ROV transects surveyed in 2004 and 2005. Blue bathymetry is from multibeam surveys conducted between 2000 and 2006. Yellow points are the combined training and validation sets of yelloweye rockfish observations (n = 164). Soundings are in fathoms.

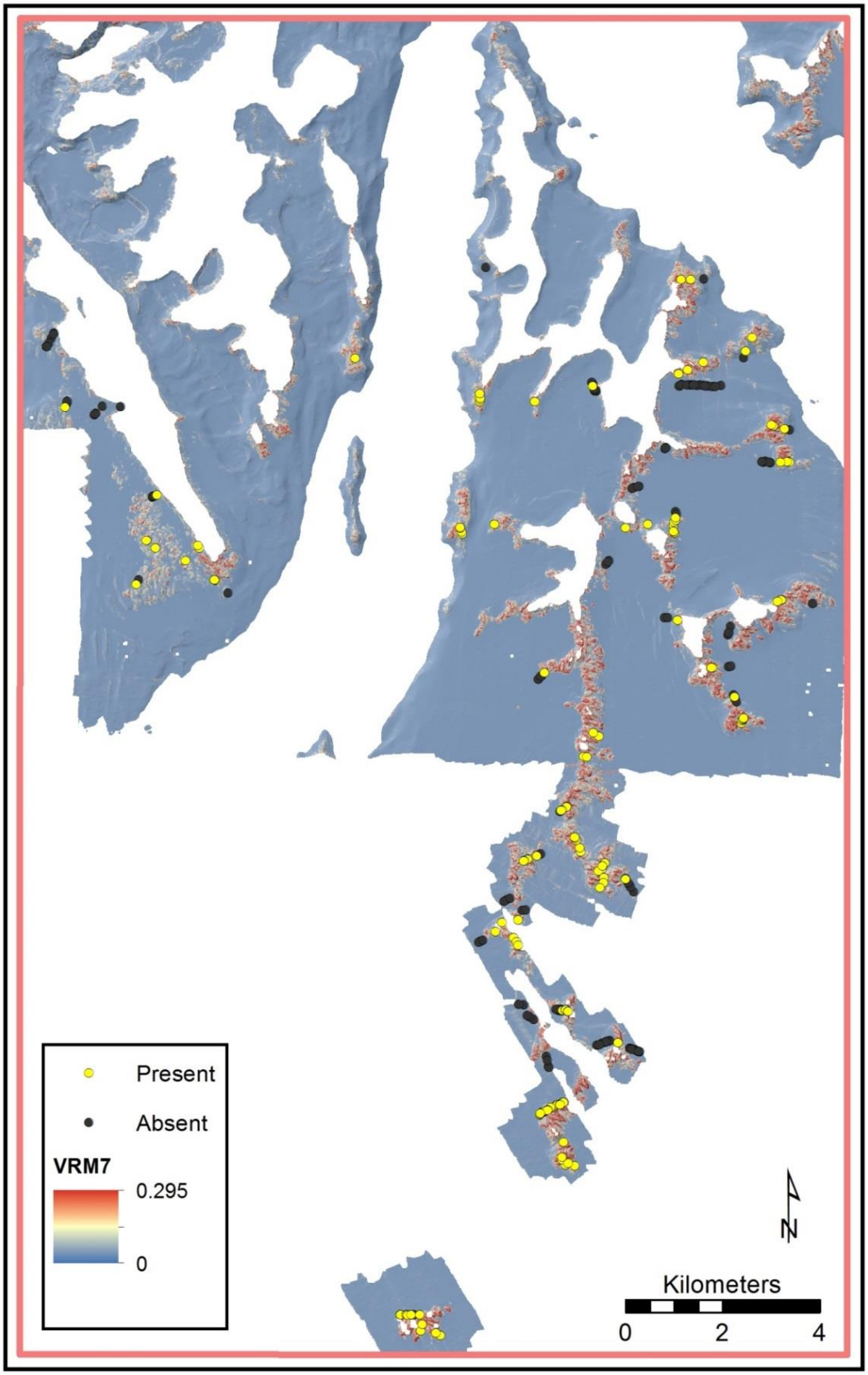

Figure 3. Vector rugosity measure (VRM) calculated with a scale factor of 7 in the Chiswell area. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

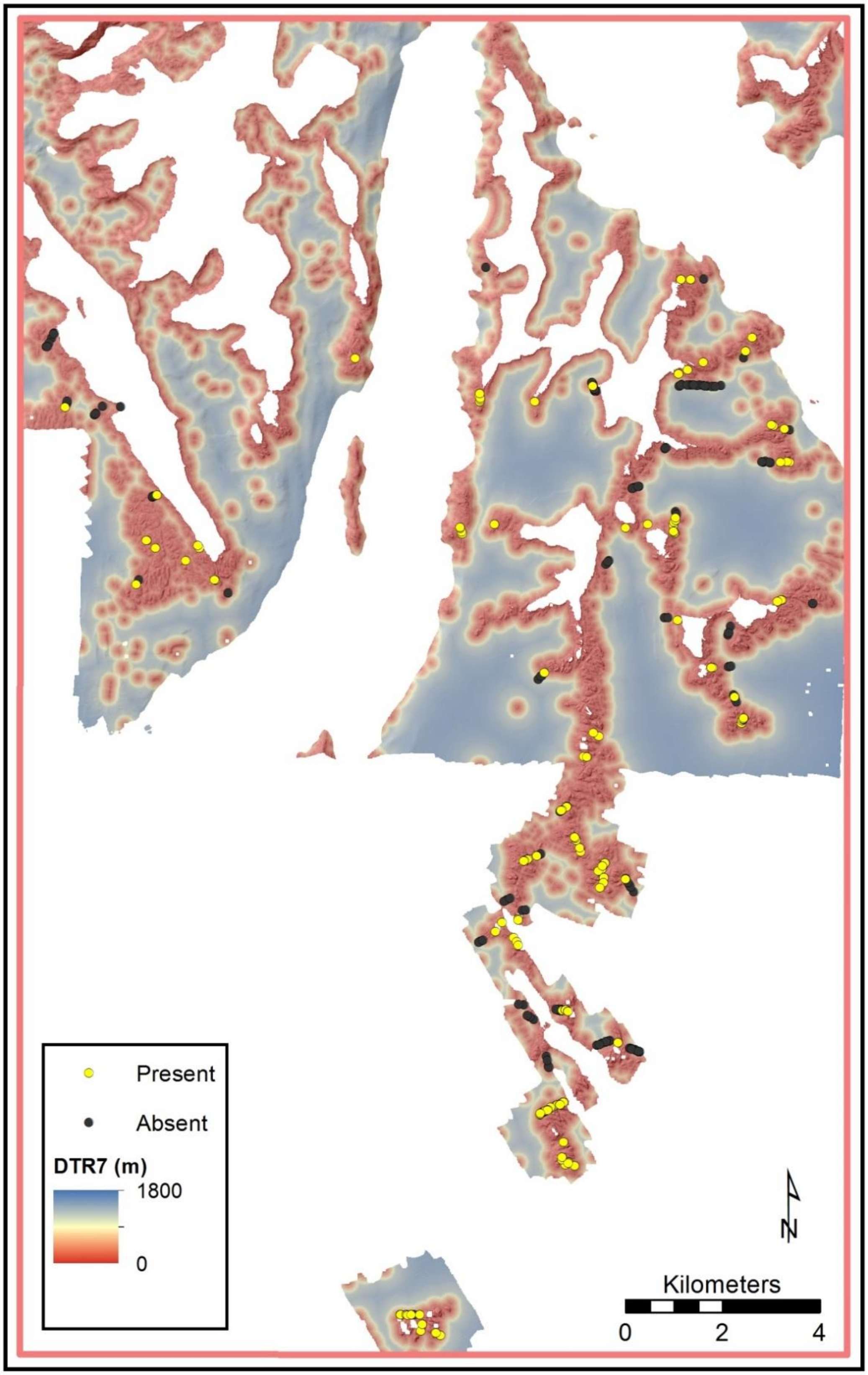

Figure 4. Distance-to-rock (DTR) calculated as distance to VRM7 peaks in the Chiswell area.

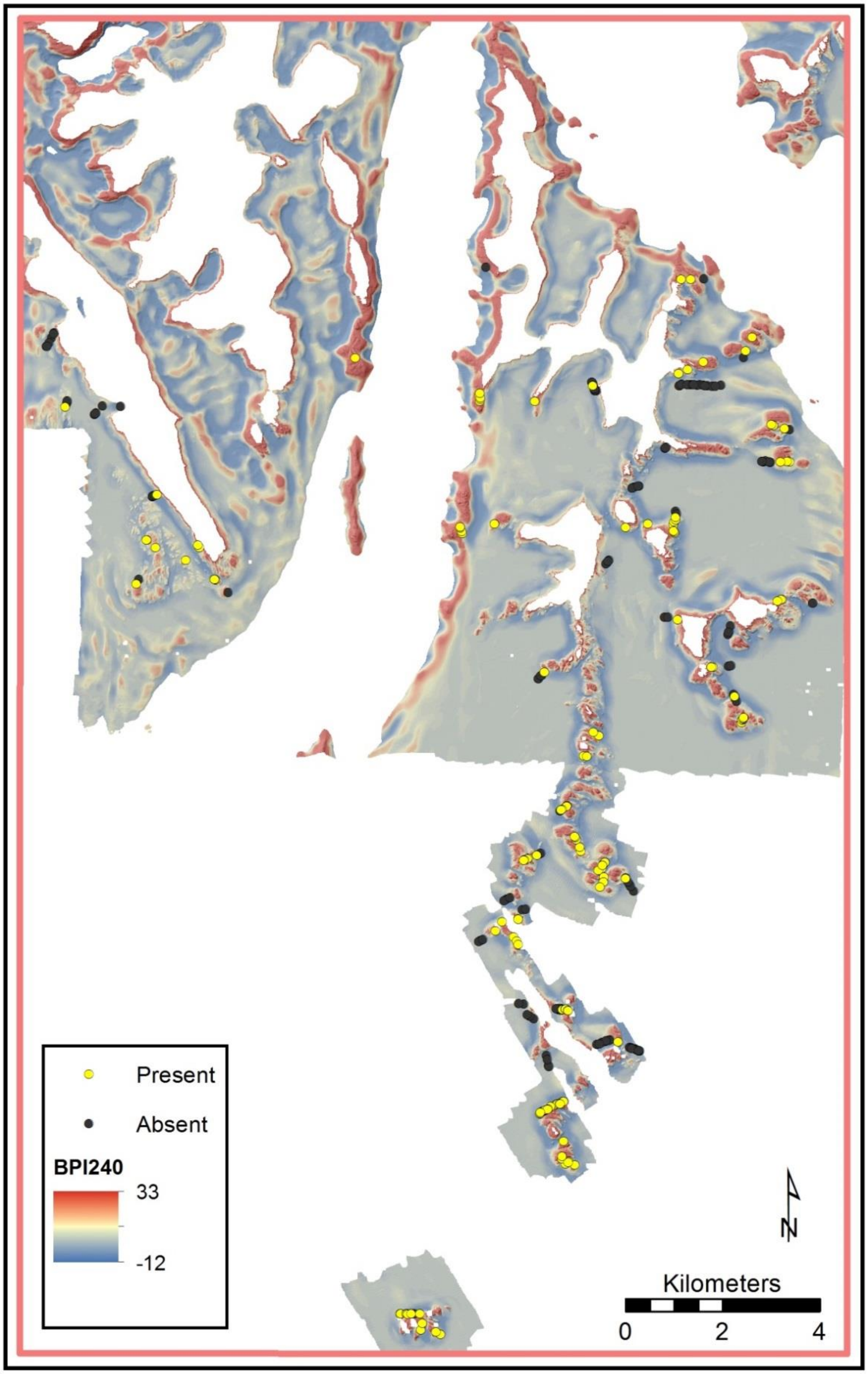

Figure 5. Bathymetric position index (BPI) calculated using a scale factor of 240 in the Chiswell area.

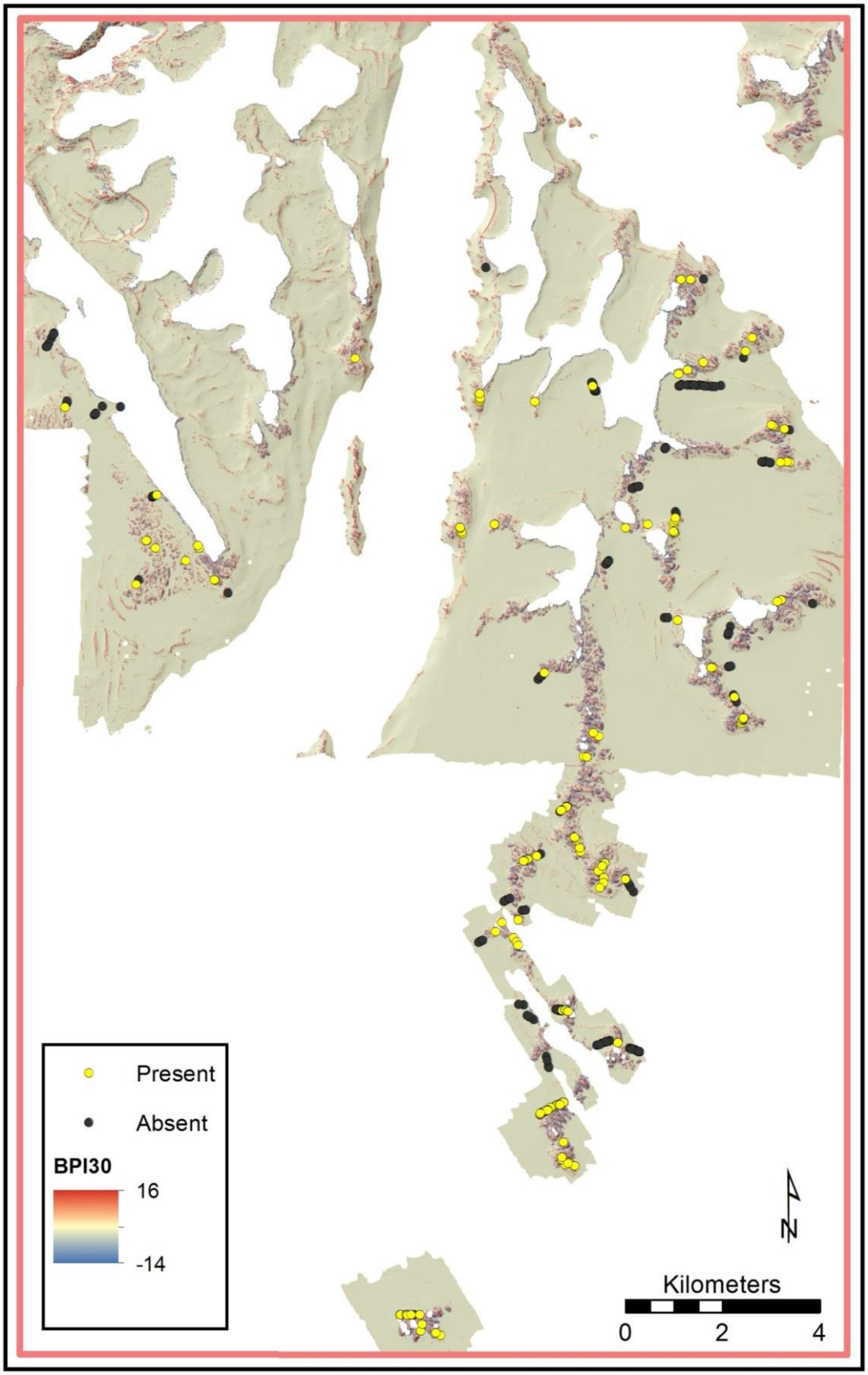

Figure 6. Bathymetric position index (BPI) calculated using a scale factor of 30 in the Chiswell area.

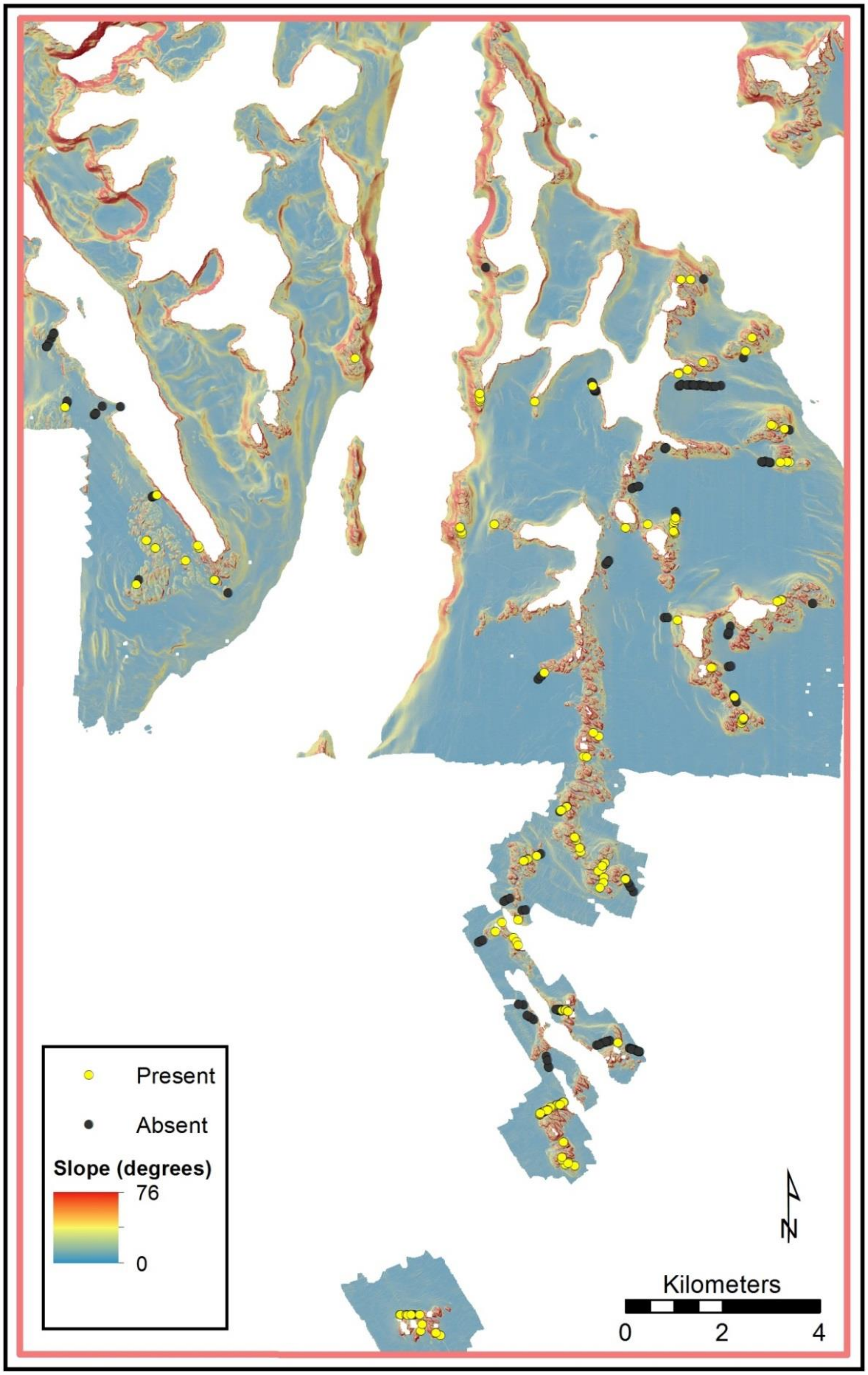

Figure 7. Slope in the Chiswell area.

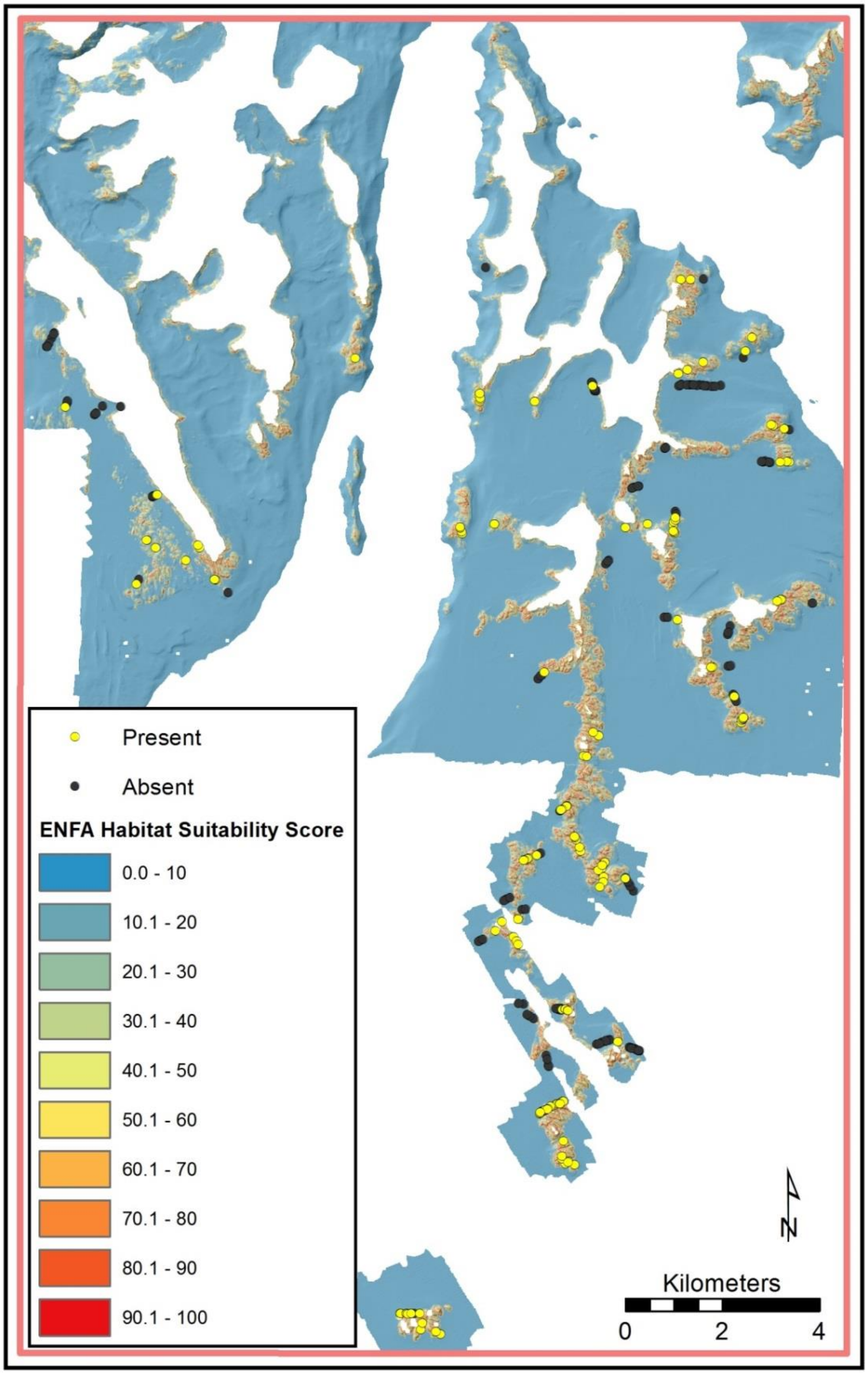

Figure 8. Habitat suitability score for yelloweye rockfish in the Chiswell area, based on the ecological niche factor analysis. Higher value indicates more suitable habitat. The ENFA used only presence points. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

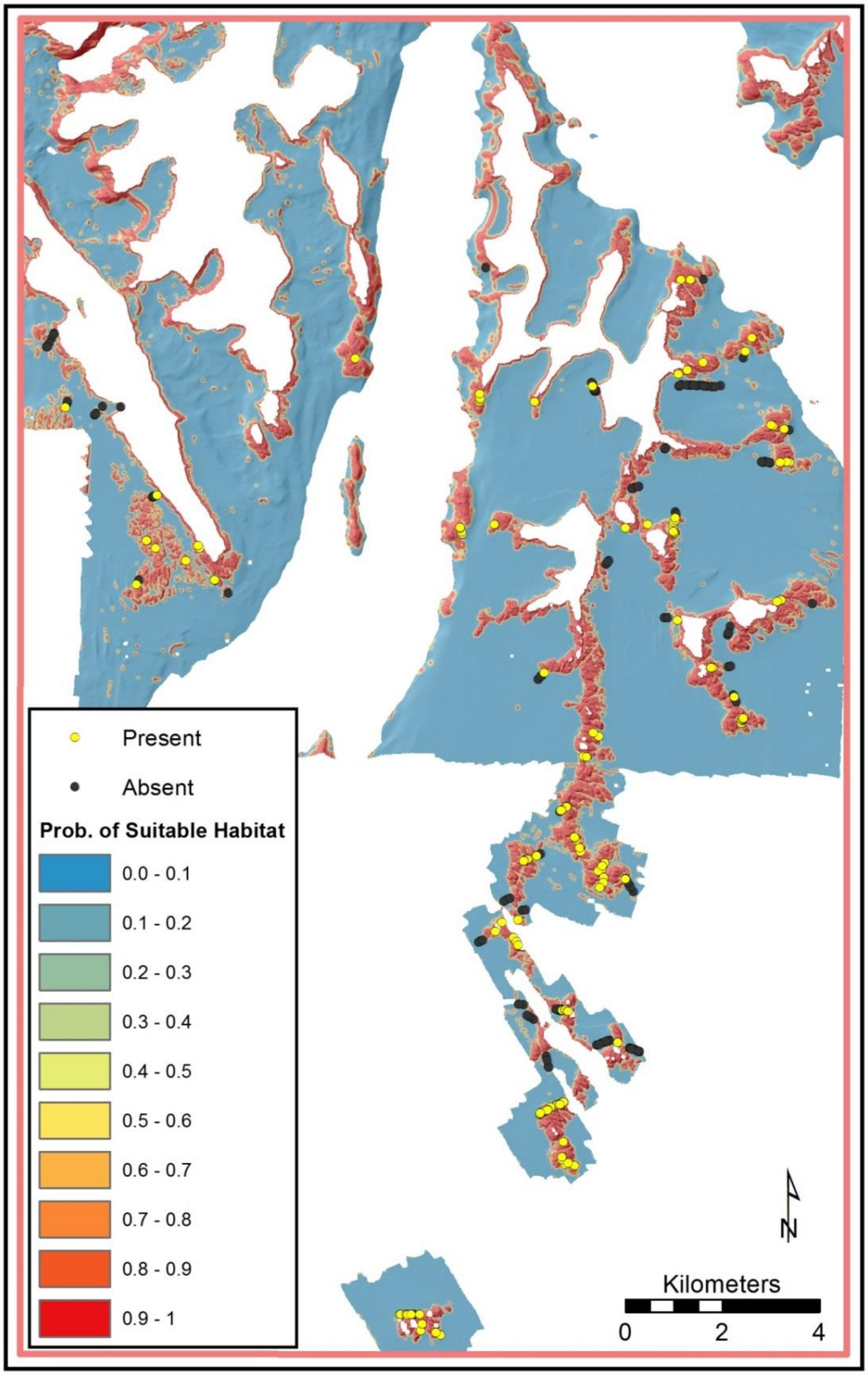

Figure 9. Probability of suitable yelloweye rockfish habitat in the Chiswell area based on the GLM fit to the Chiswell area using DTR7, VRM7, Slope, and BPI240. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

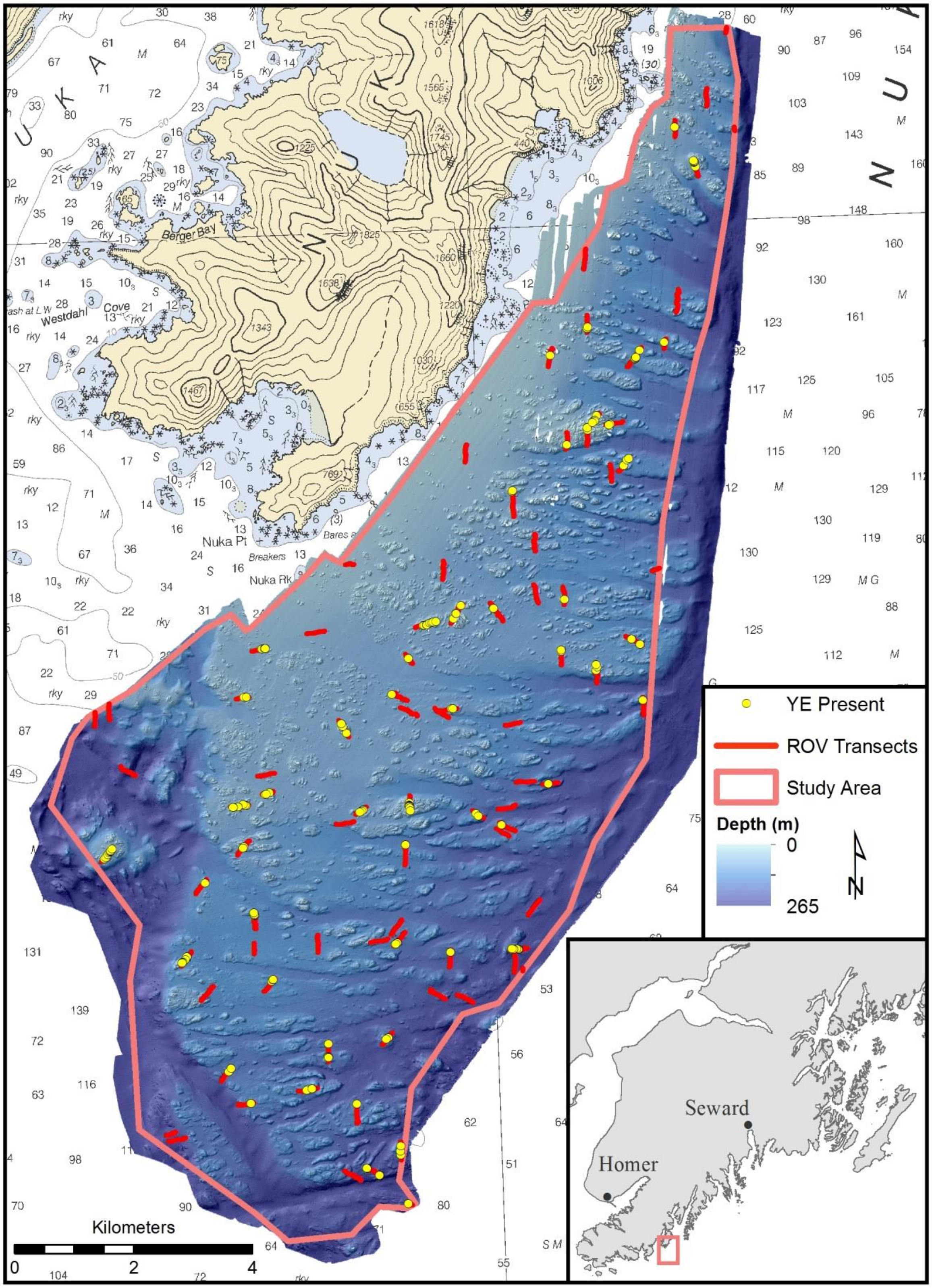

Figure 10. Nuka Island study area. Red lines are ROV transects surveyed in 2009. Blue bathymetry was surveyed in 2008. Soundings are in fathoms. Yellow points are the combined training and validation sets of yelloweye rockfish observations (n = 169).

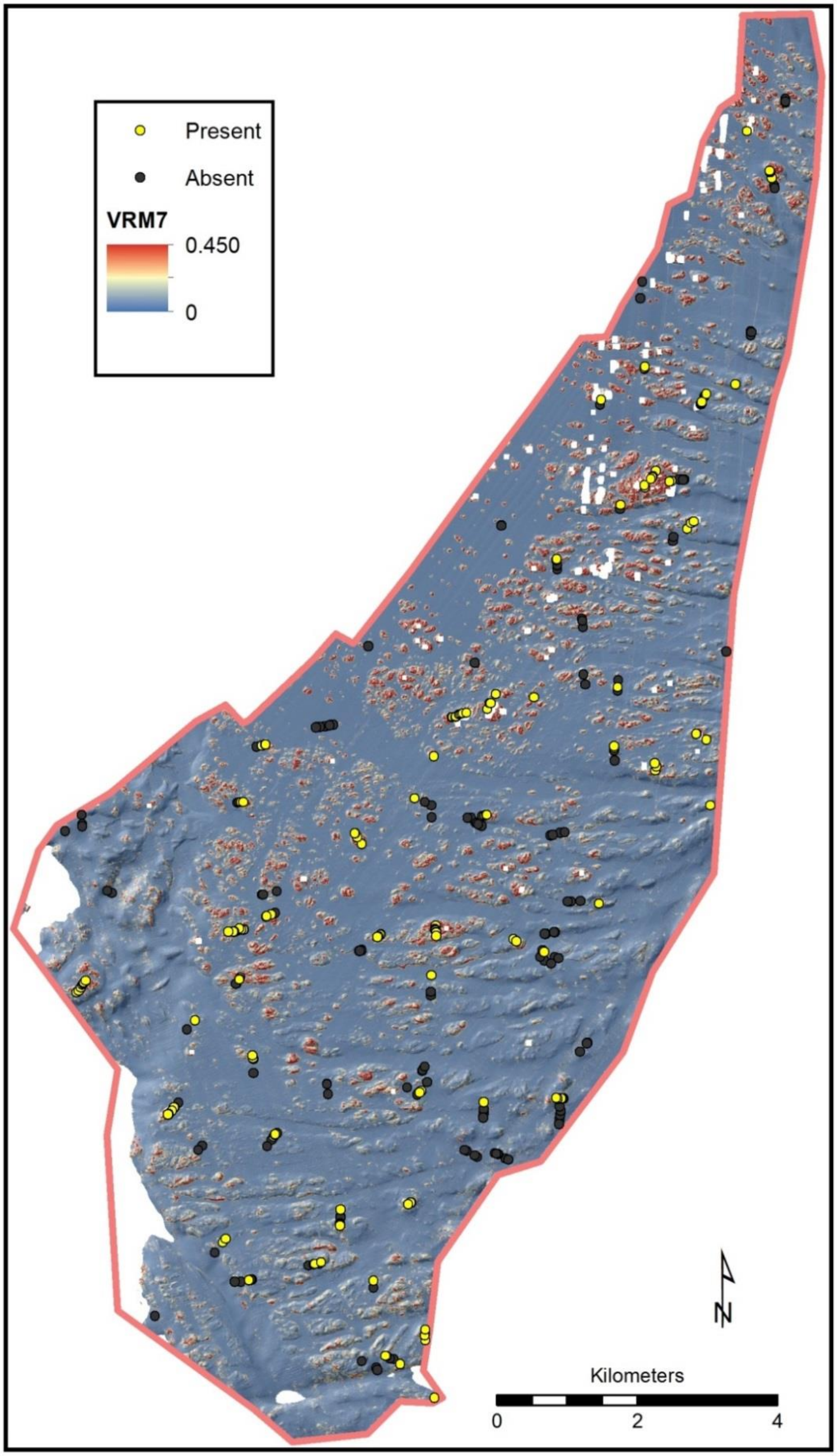

Figure 11. Vector rugosity measure calculated with a scale factor of 7 in the Nuka area. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

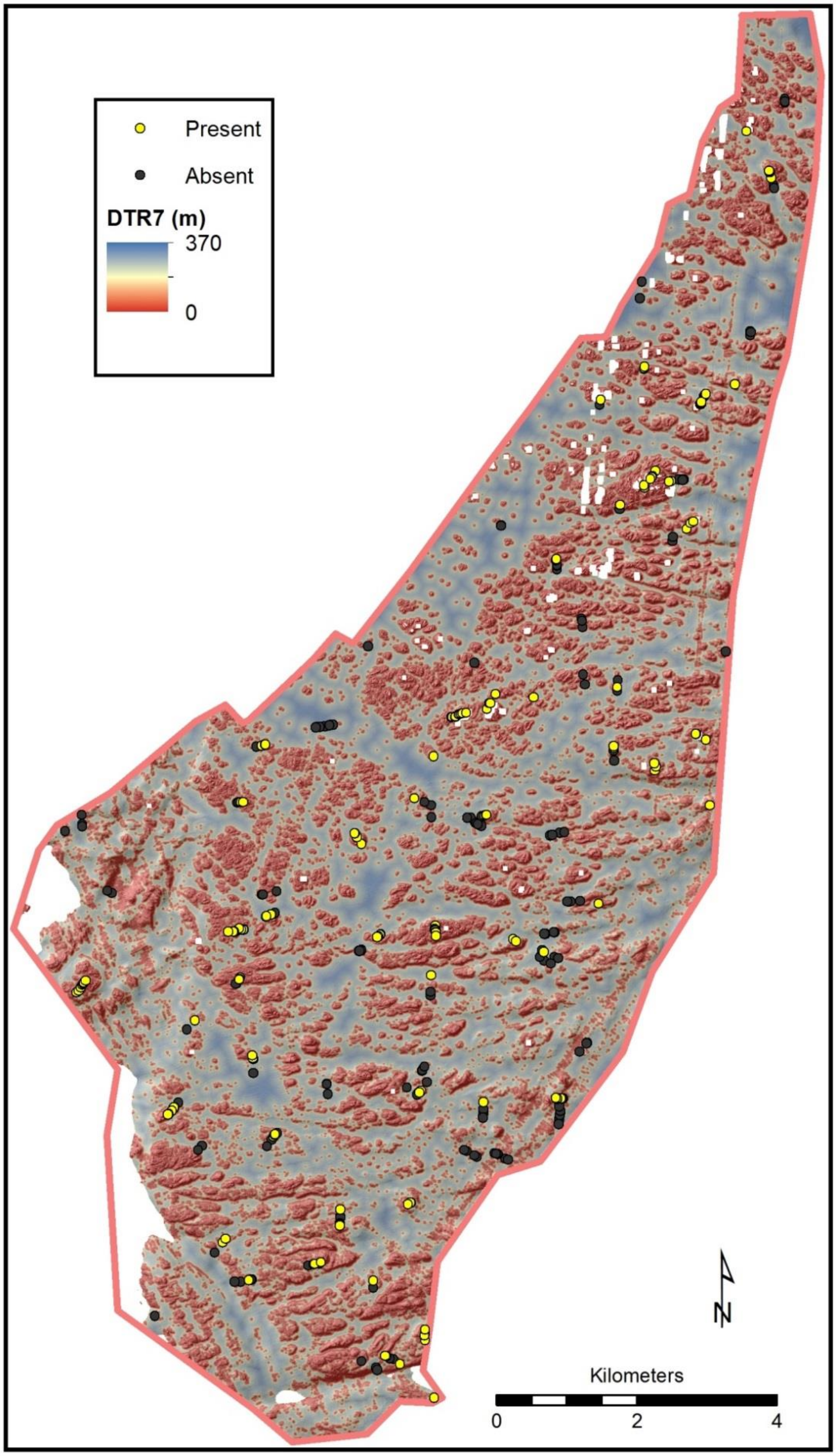

Figure 12. Distance-to-rock (DTR) calculated as distance to VRM7 peaks in the Nuka area.

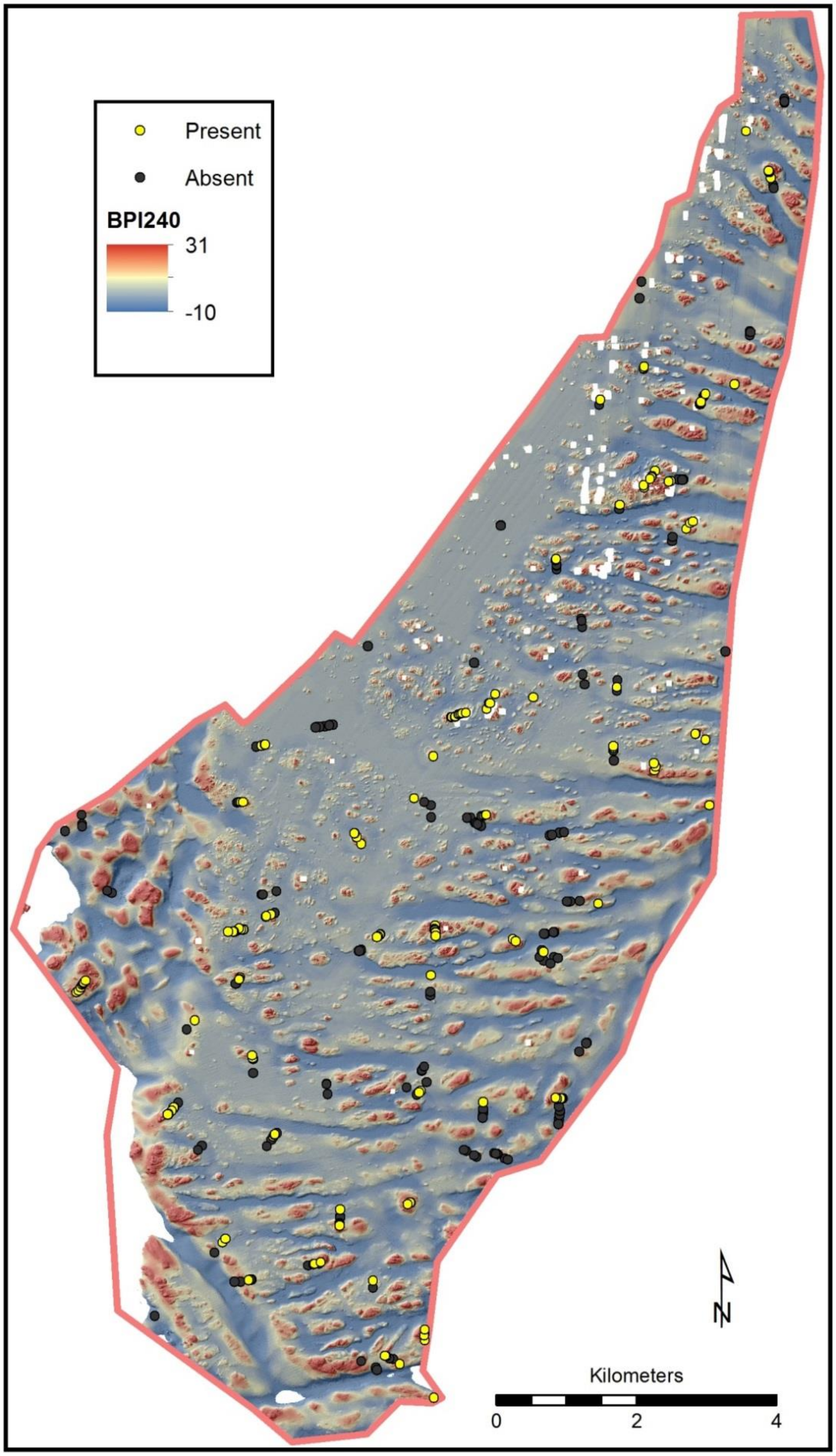

Figure 13. Bathymetric position index (BPI) calculated using a scale factor of 240 in the Nuka area.

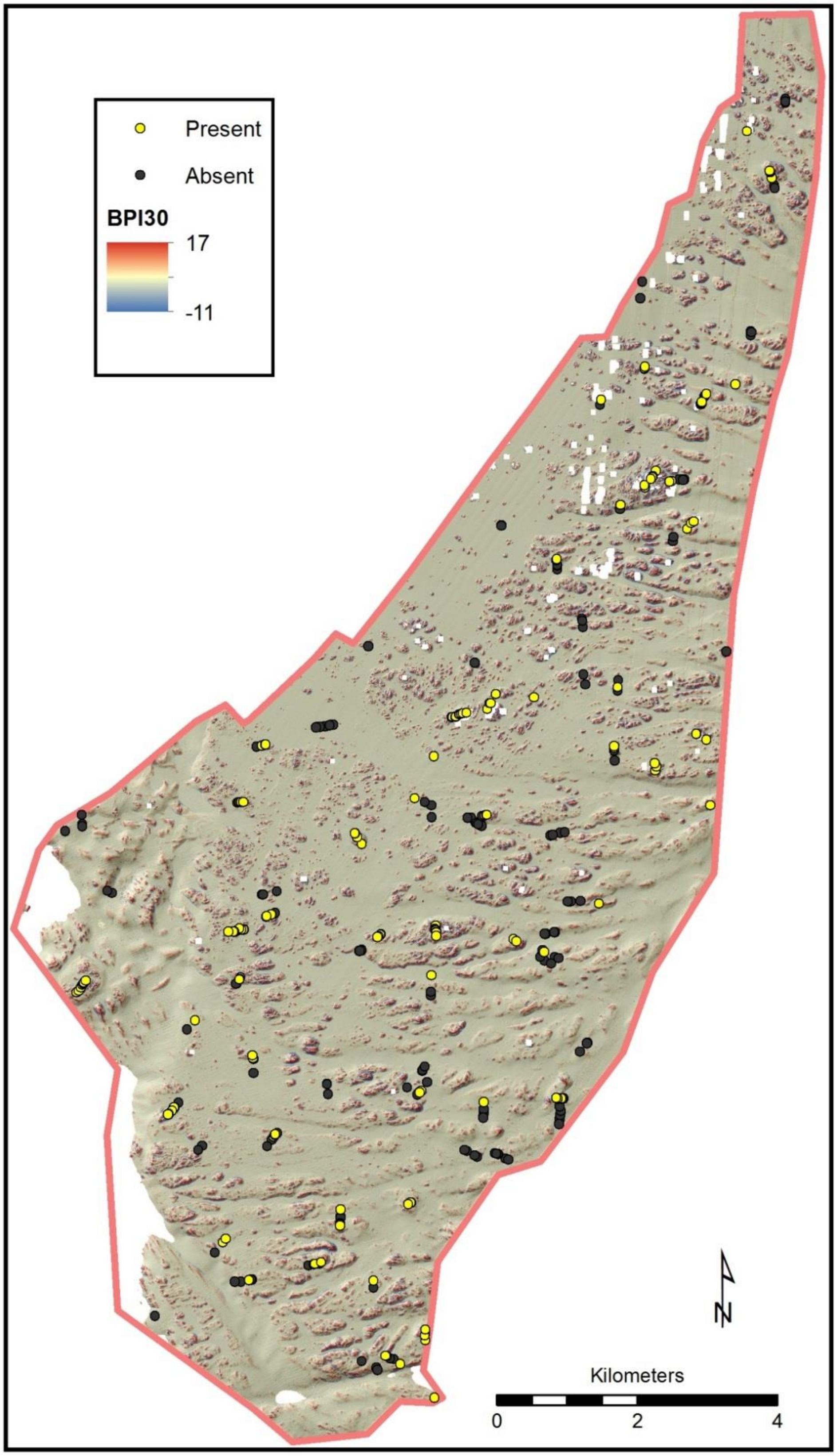

Figure 14. Bathymetric position index (BPI) calculated using scale factor of 30 in the Nuka area.

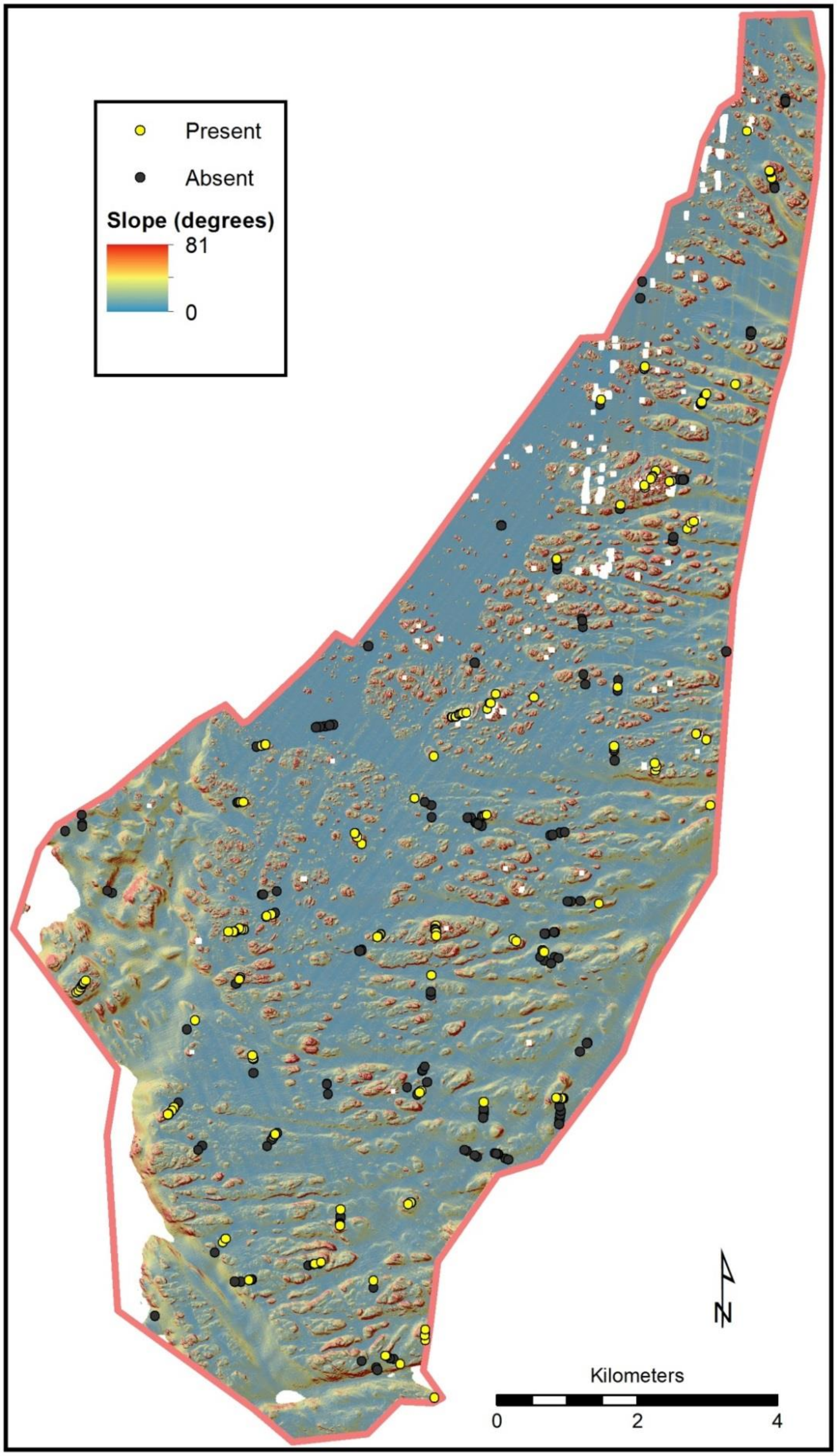

Figure 15. Slope in the Nuka area.

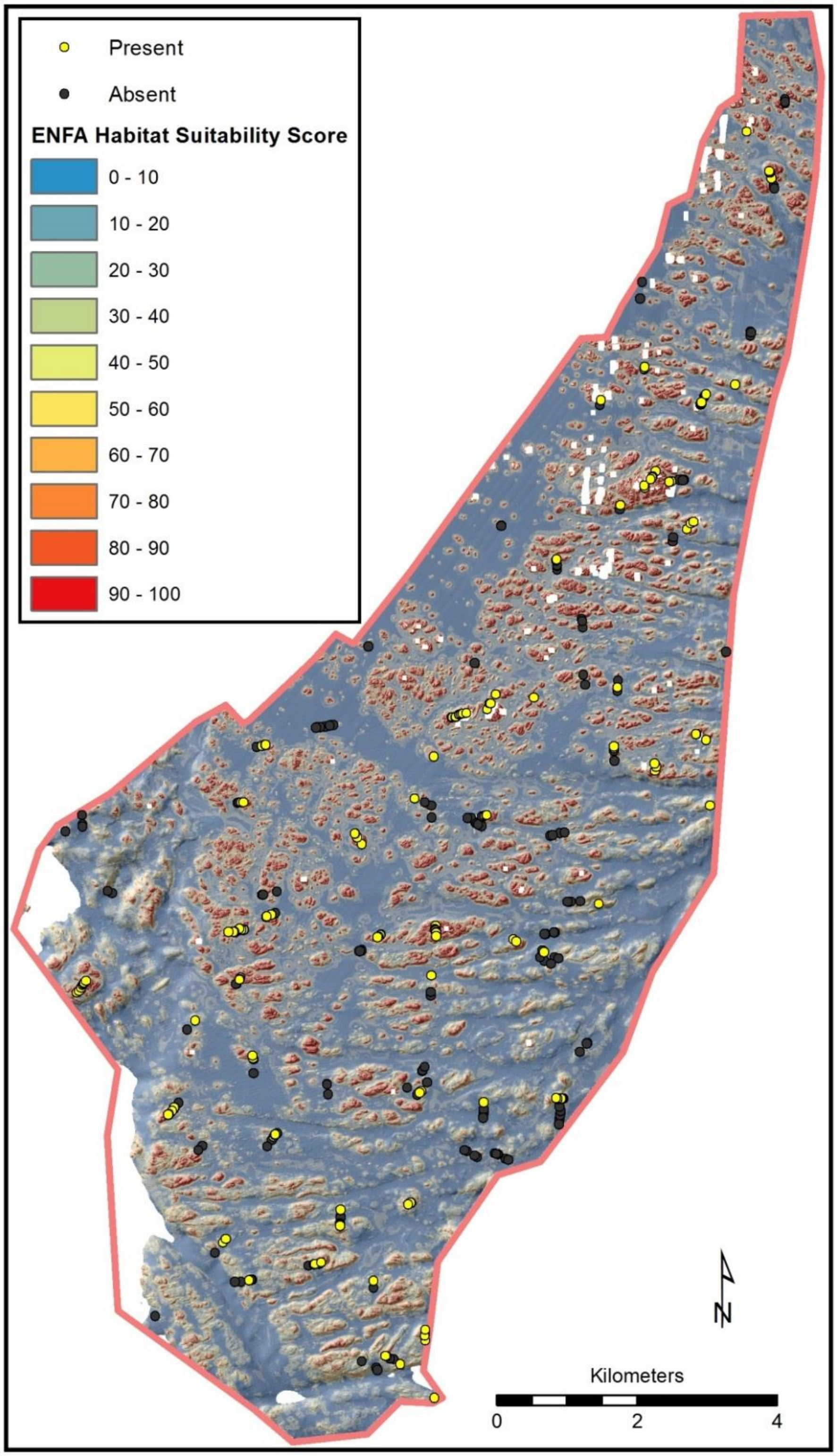

Figure 16. Habitat suitability score for yelloweye rockfish in the Nuka area, based on the ecological niche factor analysis. Higher value indicates more suitable habitat. The ENFA used only presence points. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

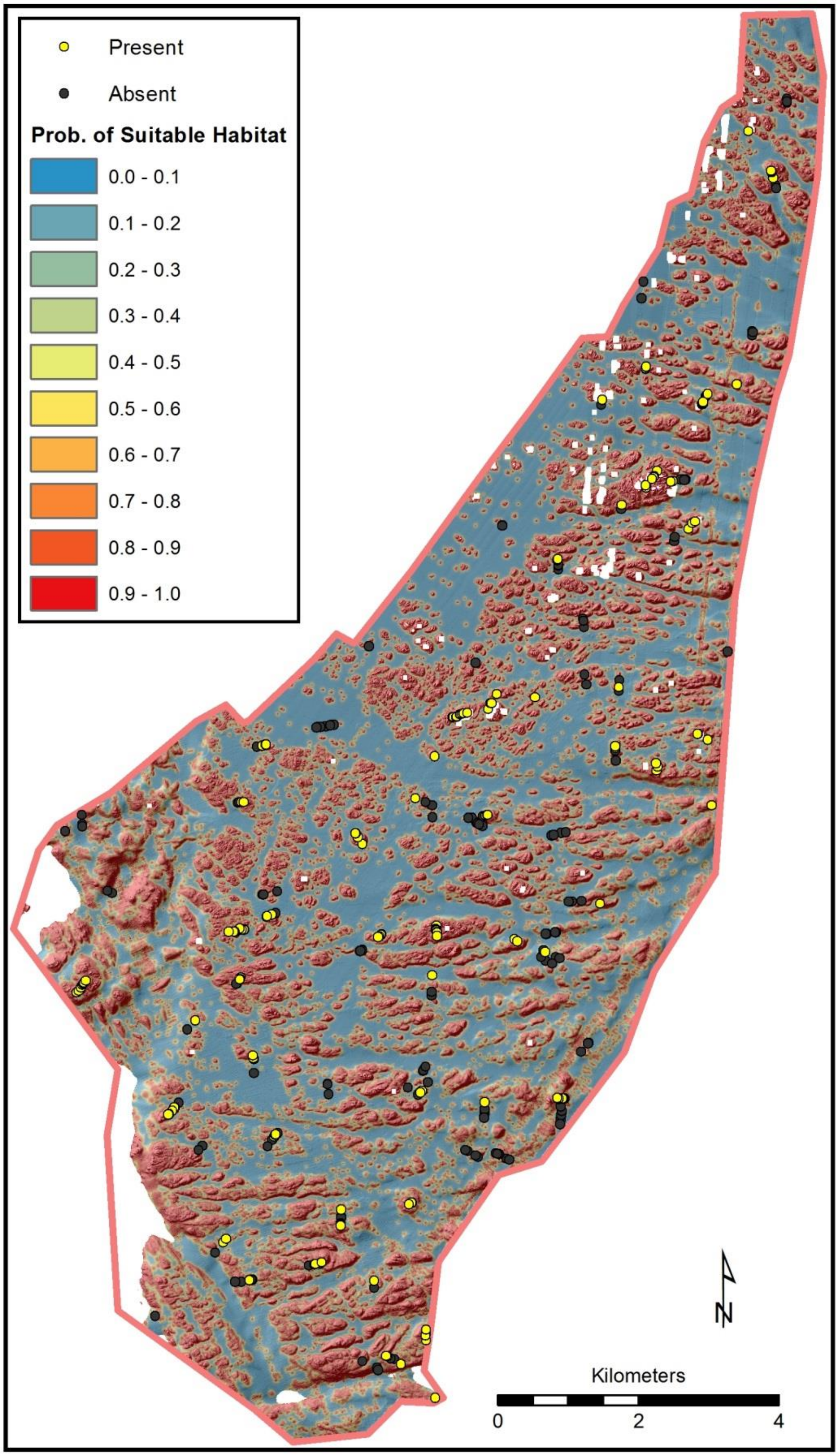

Figure 17. Probability of suitable yelloweye rockfish habitat in the Nuka area based on the GLM fit to the Chiswell area using DTR7, VRM7, slope, and BPI240. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

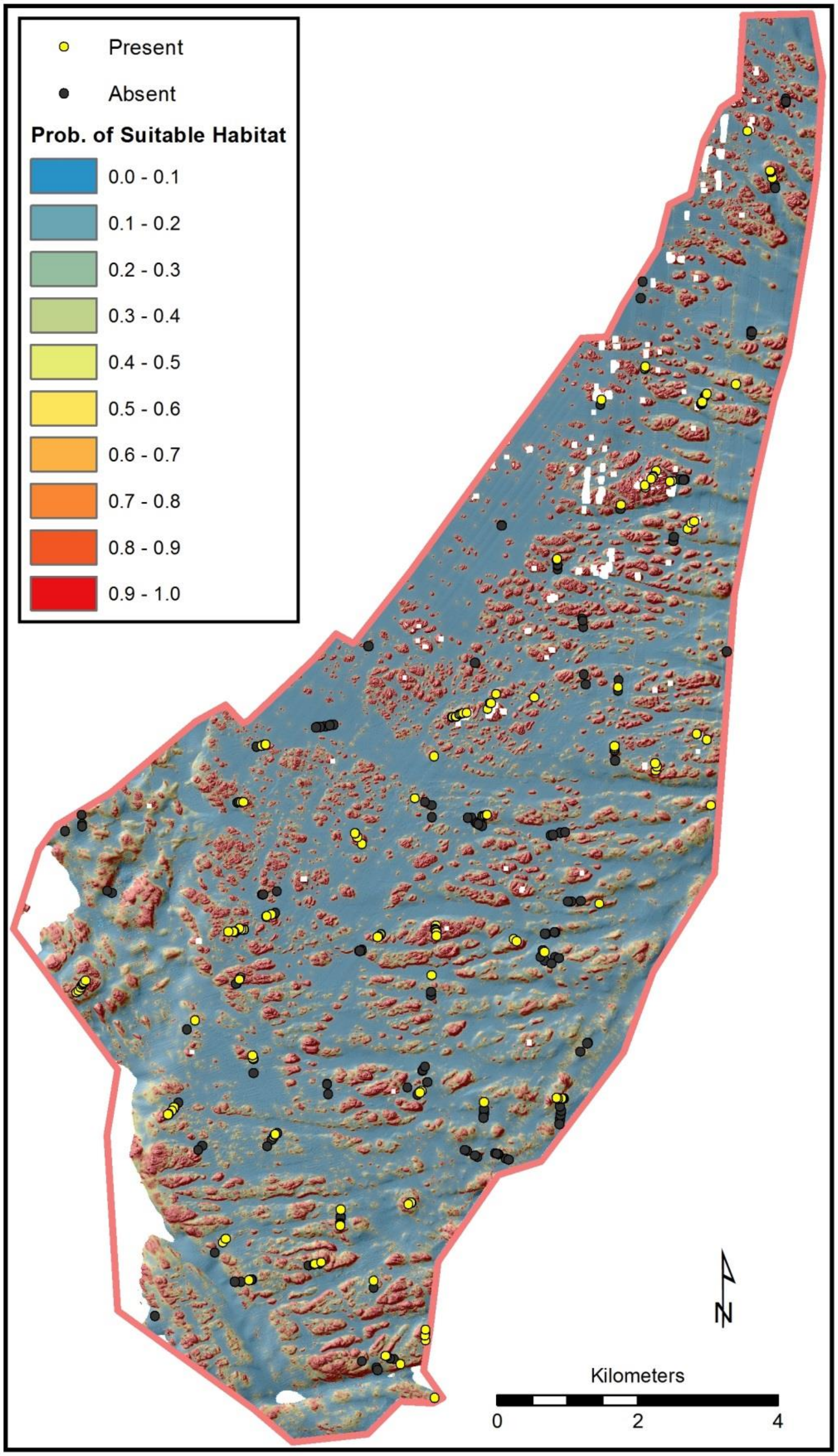

Figure 18. Probability of suitable yelloweye rockfish habitat in the Nuka area based on a GLM using the same variables selected for the Chiswell area (DTR7, VRM7, slope, and BPI240) reparametrized to the Nuka area. Yellow points are the combined training and validation sets of yelloweye rockfish observations. Black points are the combined training and validation set of absence points.

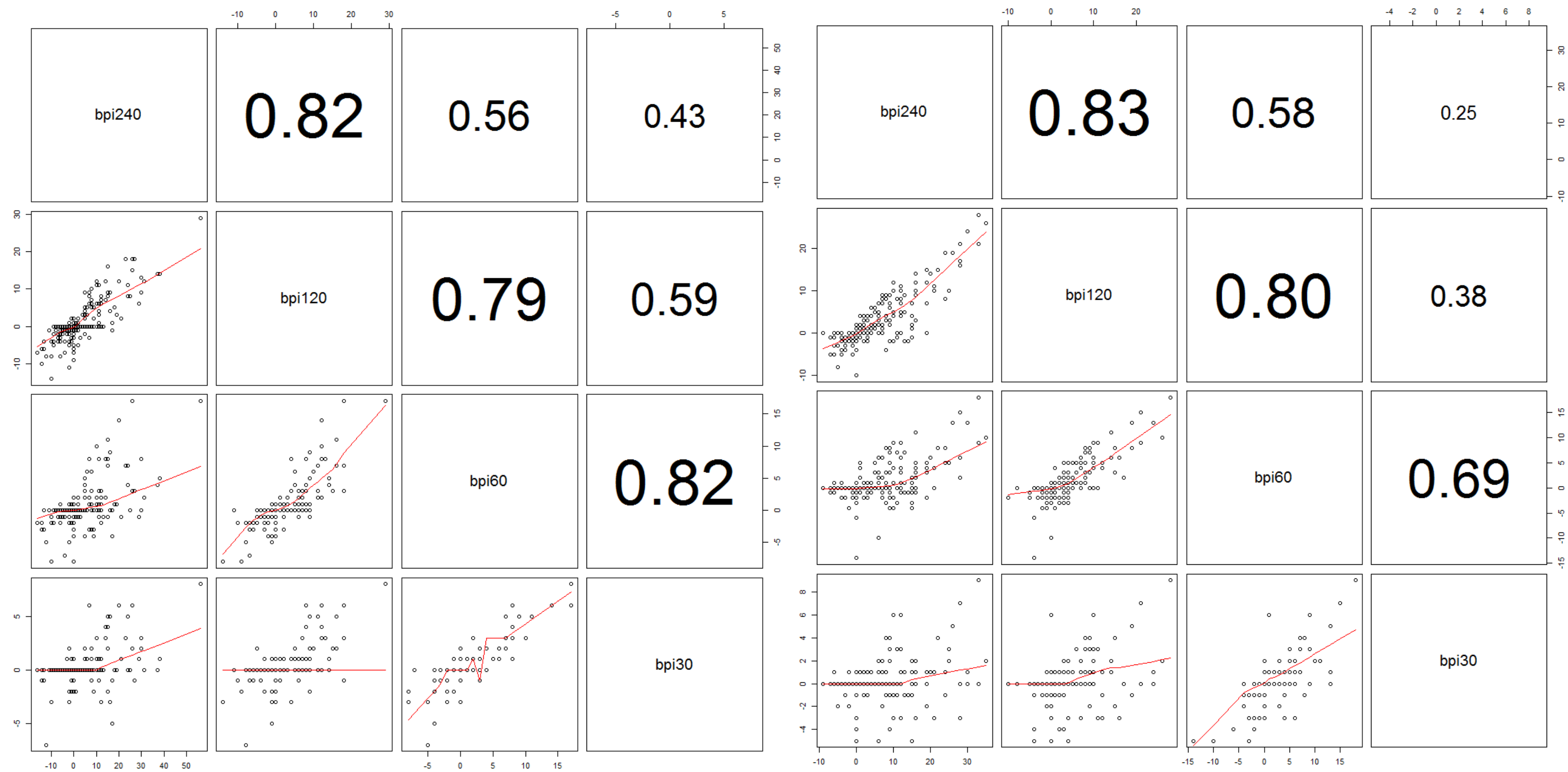

Figure 19. Correlogram of the four scales of BPI in the Chiswell area (left) and Nuka area (right). Values are Pearson correlation coefficients.

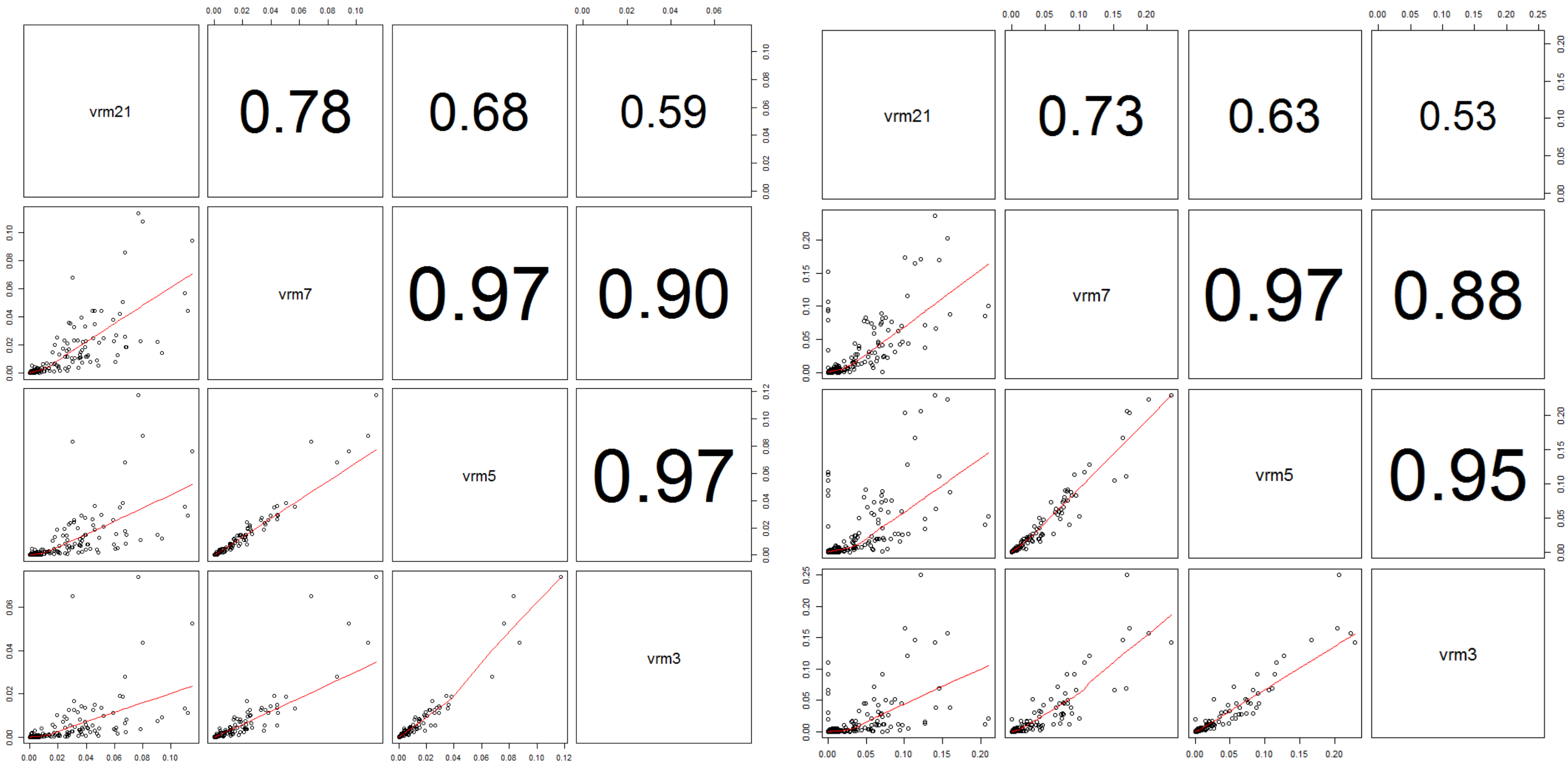

Figure 20. Correlogram of the four scales of VRM in the Chiswell area (left) and Nuka area (right).

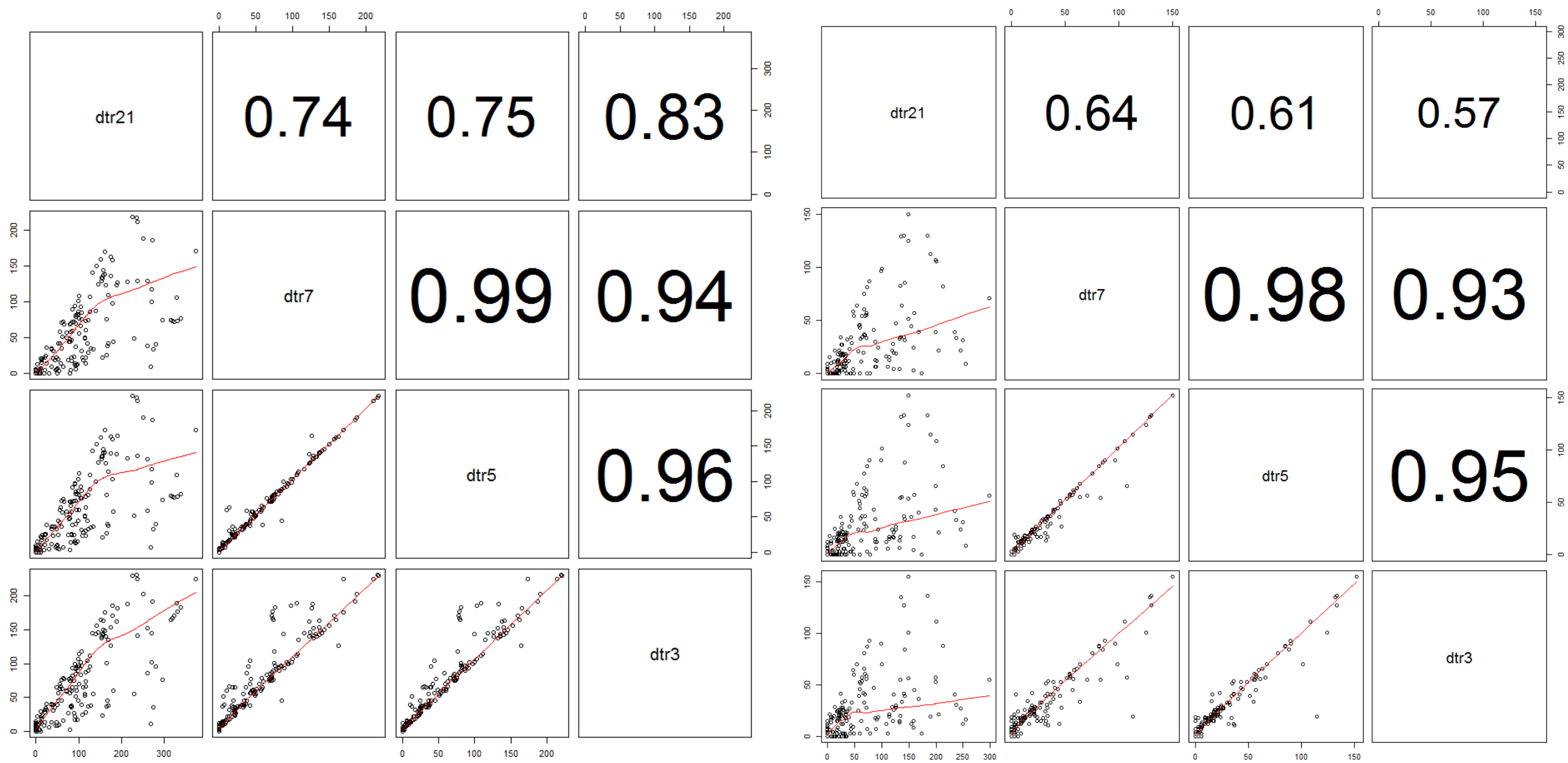

Figure 21. Correlogram of the four scales of DTR in the Chiswell area (left) and Nuka area (right).

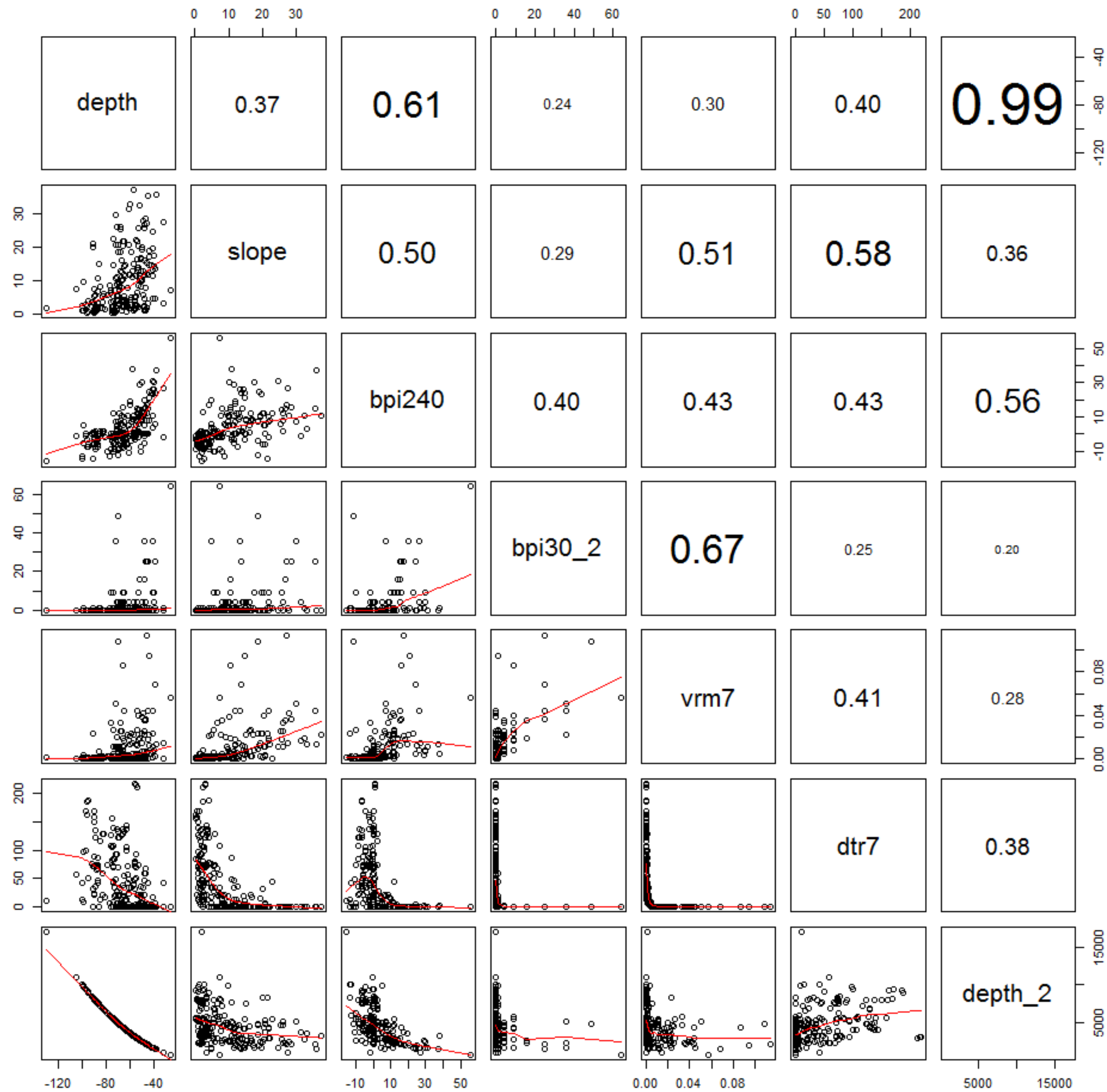

Figure 22. Correlogram of the six variables included in the scope of the final stepwise AIC variable selection process for the GLMs using data from the Chiswell area. Subscripts indicate quadratic transformations.

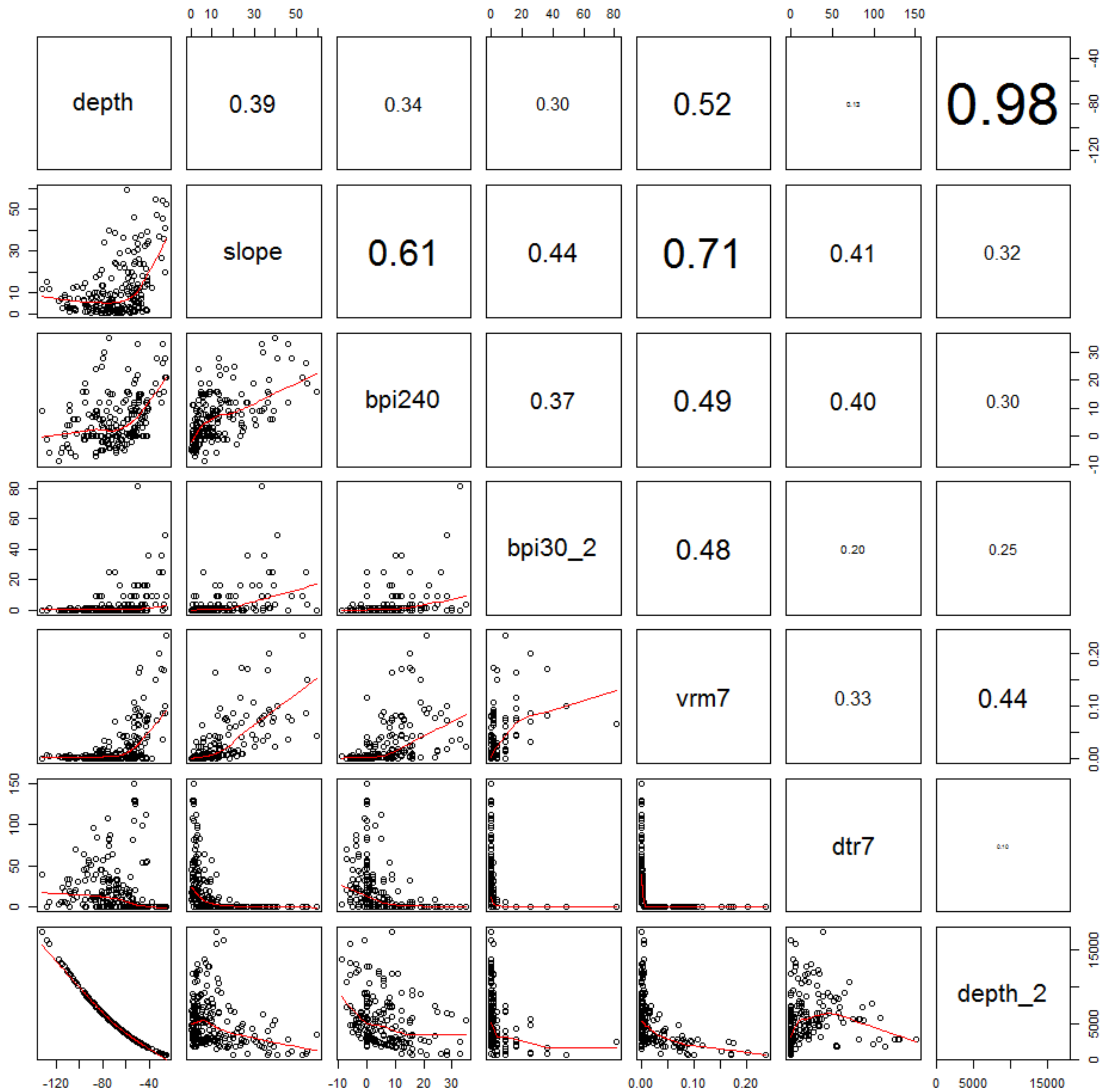

Figure 23. Correlogram of the six variables included in the scope of the final stepwise AIC variable selection process for the GLMs using data from the Nuka area. Subscripts indicate quadratic transformations.

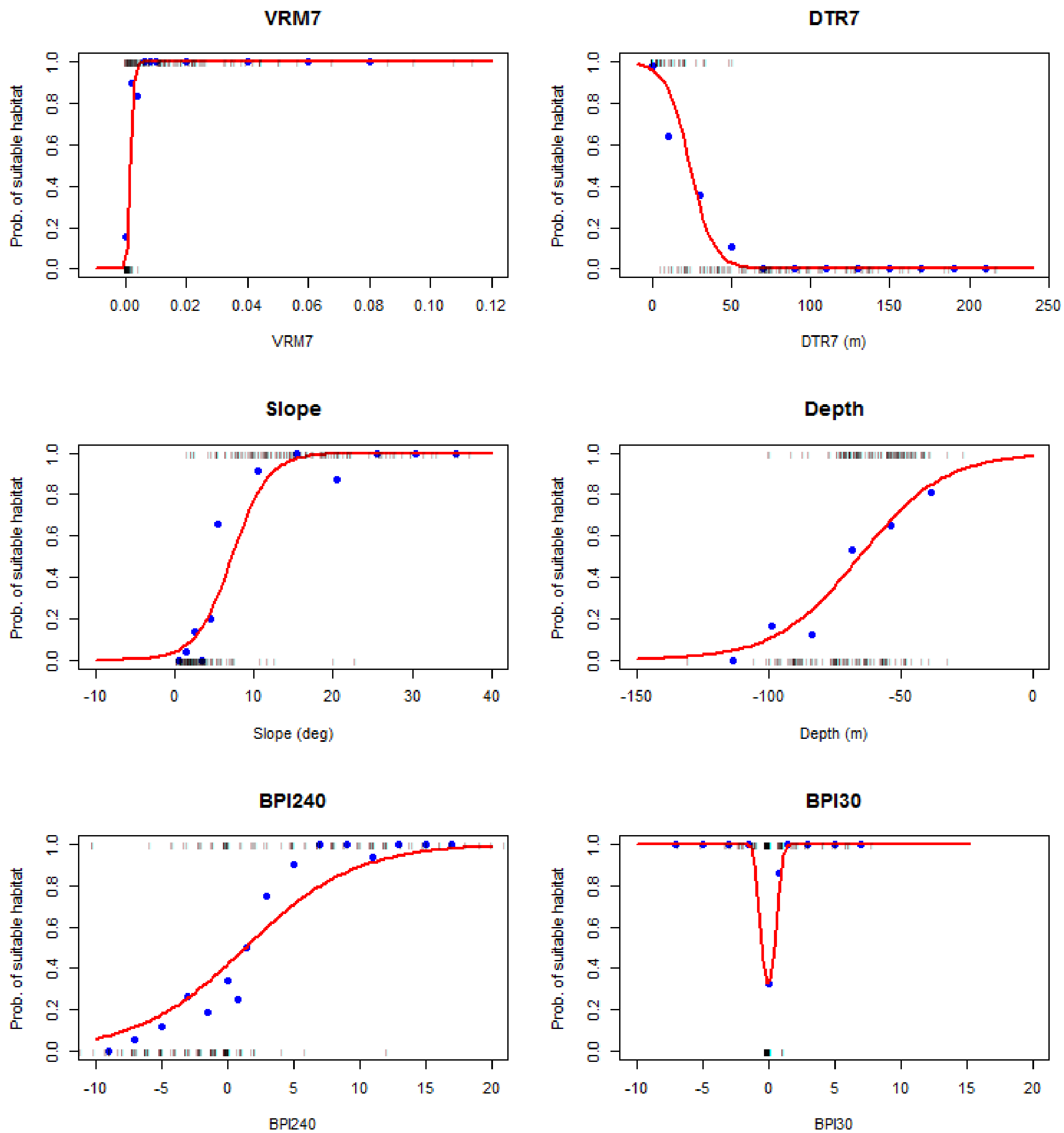

Figure 24. Simple logistic regression curves for the Chiswell area relating probability of suitable yelloweye habitat to the six variables selected for inclusion in the final stepwise AIC variable selection. Blue dots are the proportion of presence out of all observations for a given bin. Black tics are individual point observations.

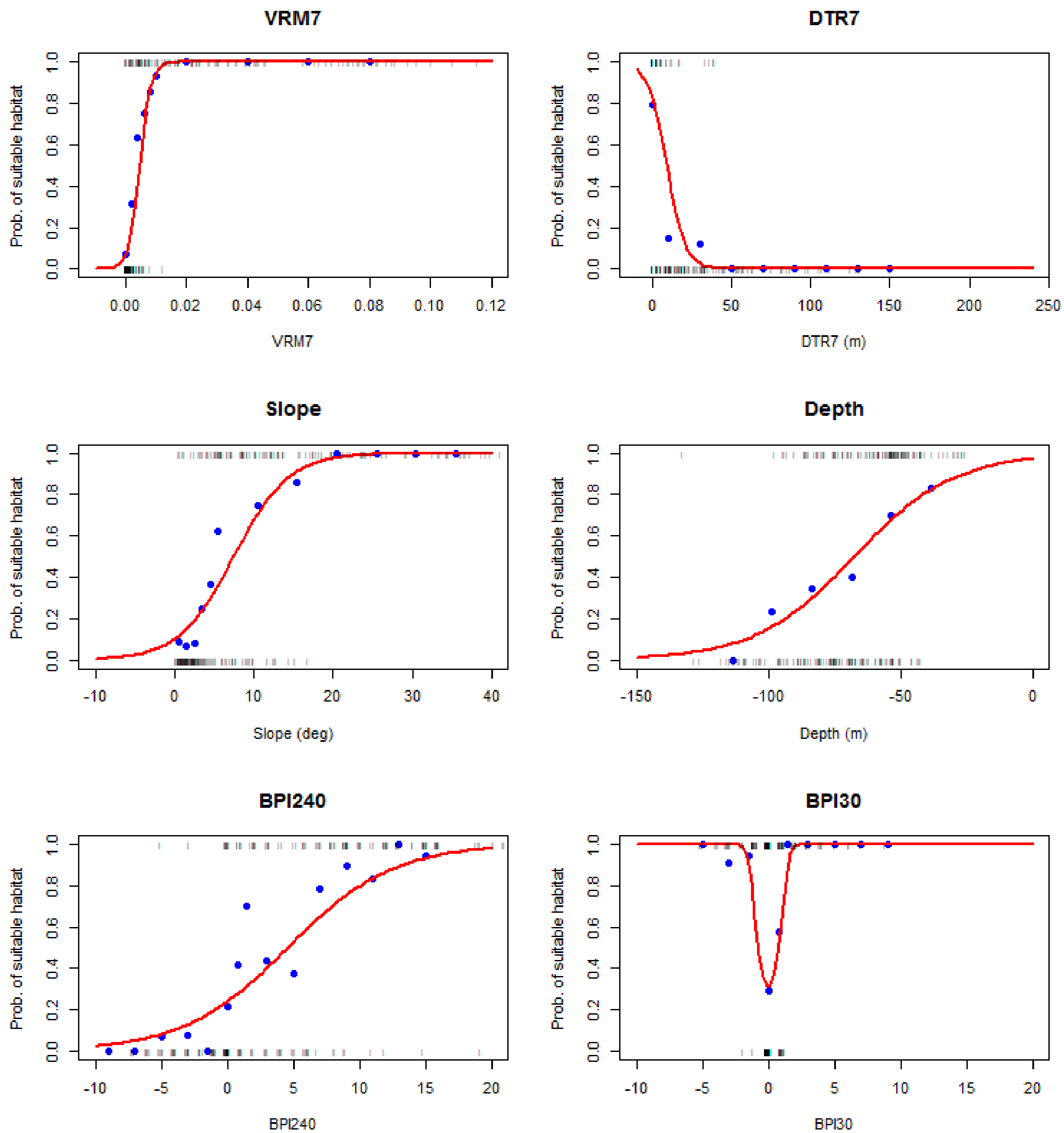

Figure 25. Simple logistic regression curves for the Nuka area relating probability of suitable yelloweye habitat to the six variables selected for inclusion in the final stepwise AIC variable selection. Blue dots are the proportion of presence out of all observations for a given bin. Black tics are individual point observations.

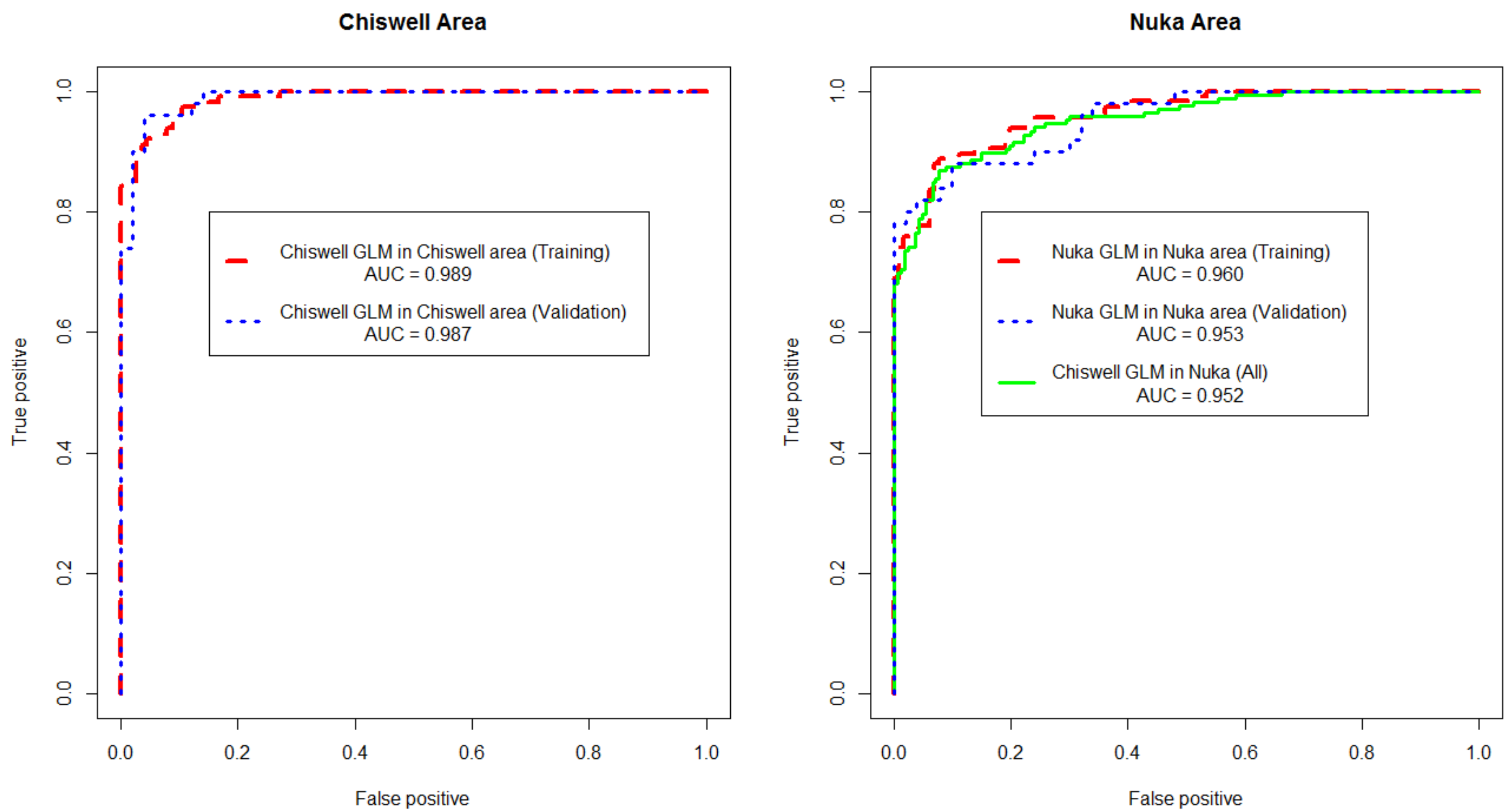

Figure 26. Receiver Operator Characteristic (ROC) plots for the GLMs applied to the Chiswell area (left) and Nuka area (right). The blue lines evaluate the performance of the models using the training datasets, while red use the reserved validation set of points. The green line represents the Chiswell model validated in the Nuka area and uses the combined training and evaluation datasets because none of these data were used to fit the model. For reference, a completely random classification would appear as a diagonal line through the origin with slope = 1 and would produce an AUC of 0.5, while a perfect classification would yield an AUC of 1.0

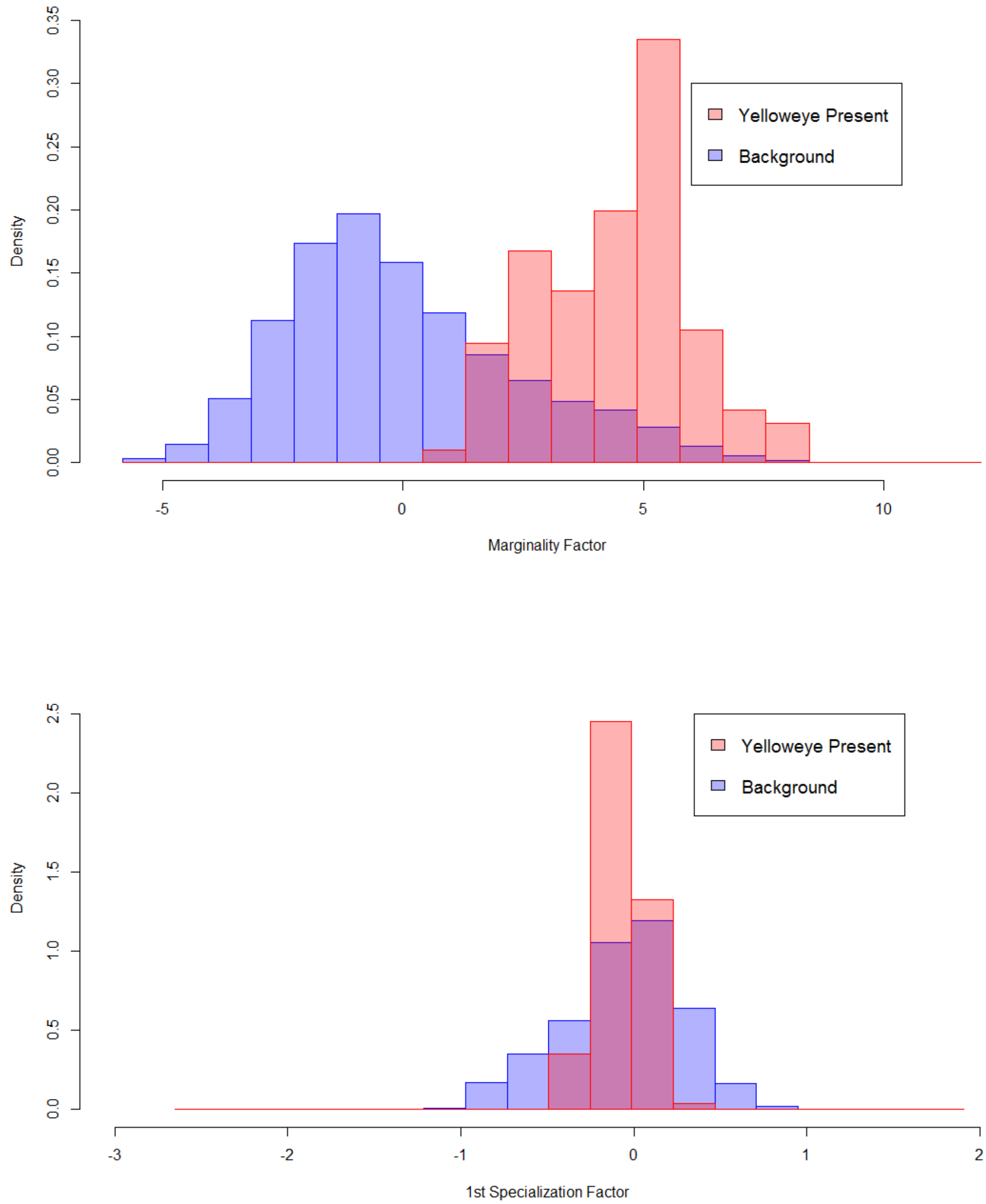

Figure 27. Distribution of yelloweye across the first two ecological factors of the ENFA in the Chiswell area. Red is the distribution of yelloweye presence. Blue is the global distribution of the greater study area. Top panel is the marginality factor. Bottom panel is the first specialization factor. The second and third specialization factors were omitted to save space, but showed the same general pattern as the first specialization factor in which the distribution of the presence points was centered about a mean similar to the mean of the background distribution and more narrowly dispersed.

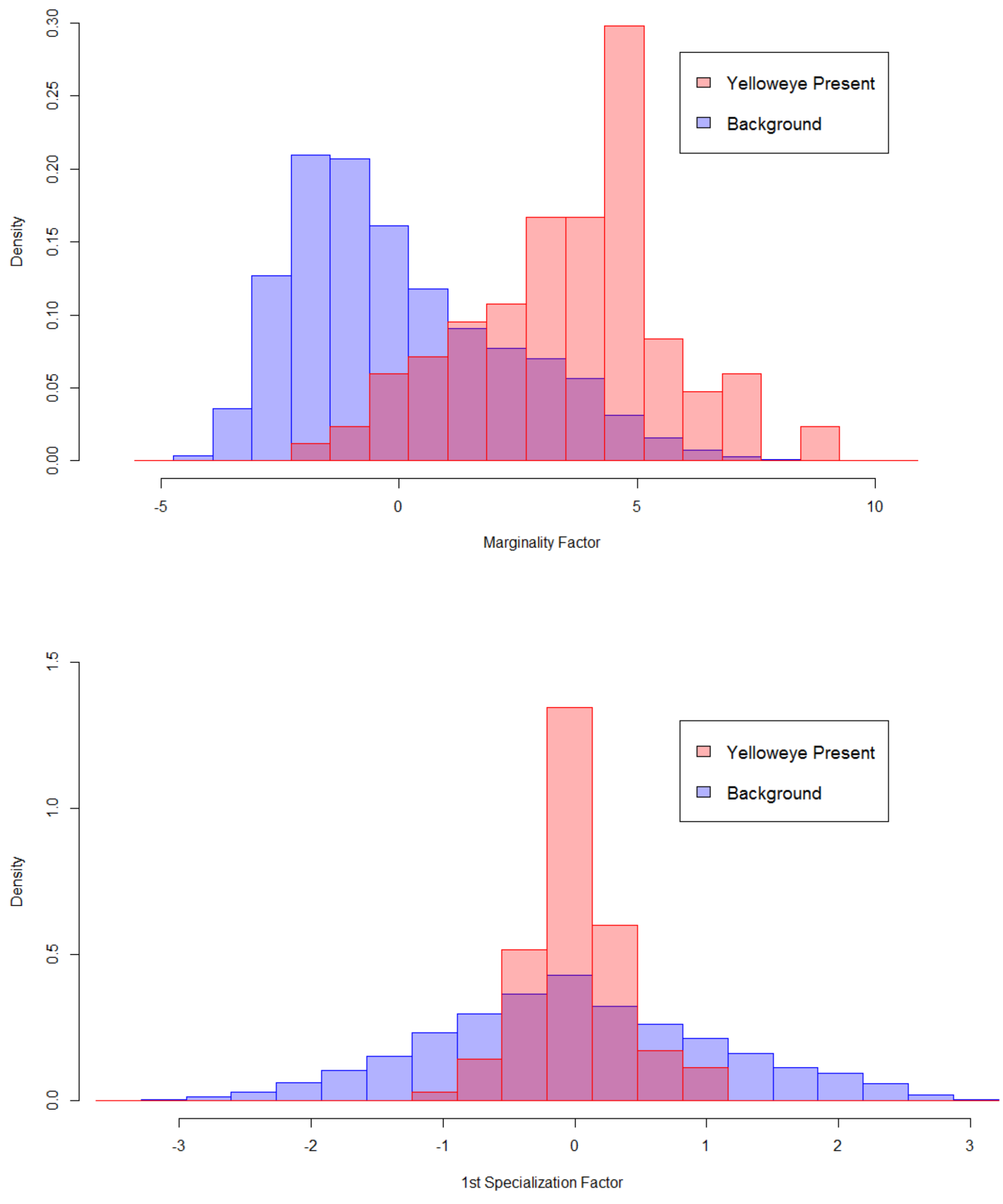

Figure 28. Distribution of yelloweye across the first two ecological factors of the ENFA in the Nuka area. Red is the distribution of yelloweye presence. Blue is the global distribution of the entire study area. Top panel is the marginality factor. Bottom panel is the first specialization factor. The second and third specialization factors were omitted to save space, but showed the same general pattern as the first specialization factor in which the distribution of the presence points was centered about a mean similar to the mean of the background and more narrowly dispersed.

APENDIX

Table A.1. Terrain metrics and yelloweye rockfish presence in the Chiswell area. Coordinates are in UTM 6N.

easting	northing	present	depth (m)	slope (deg)	bpi240	bpi120	bpi60	bpi30	dtb30 (m)	dtr21 (m)	dtr7 (m)	dtr5 (m)	dtr3 (m)	vrm21	vrm7	vrm5	vrm3
341062.60	6614011.74	0	-57.2503014	1.79605	0	-1	0	0	178.6450043	261.3959961	37.9473	58.2495003	86.5851974	0.0026981	0.0008356	0.000541	0.0002403
352208.42	6600849.87	0	-69.8958969	4.1749701	-9	-2	0	0	177.102005	145.9859924	123.5479965	126.5699997	146.2940063	0.0009554	0.0001793	0.0001128	8.08E-05
354700.39	6608560.28	0	-99.0995026	1.02302	-5	0	0	0	192	178.9219971	97.7190018	103.3150024	186	1.60E-05	8.90E-06	4.30E-06	1.00E-06
342538.35	6610353.94	0	-73.5814972	7.0185199	-2	-1	-1	0	29.5466003	51.7879982	19.2094002	24.1868	45	0.0070736	0.0024989	0.0015815	0.0007488
354255.94	6614342.17	0	-84.8973999	1.82963	2	0	0	0	119.435997	270.7659912	116.4990005	117.8809967	144.8099976	6.79E-05	1.22E-05	1.10E-05	6.00E-06
352232.14	6610749.38	0	-63.4365997	3.3761599	-3	0	0	0	158.772995	157.0639954	136.8540039	139.5559998	142.2389984	0.00012	0.0001047	6.14E-05	1.29E-05
351240.96	6601500.36	0	-56.2496986	2.4876499	-1	0	0	0	93.4345016	96.8401031	81.0554962	82.3771973	94.8683014	0.0006521	0.000399	0.000209	0.0001073
352682.22	6600694.97	0	-88.0774994	1.50569	-5	-1	0	0	90	105.6829987	65.5210037	76.6615982	83.4085999	0.0004703	0.0002266	0.000233	9.50E-05
352567.10	6604199.72	0	-83.493103	3.4914801	0	2	1	0	38.4187012	108.1669998	21.6333008	22.8472996	24.1868	0.0039999	0.0019622	0.0007114	0.0001814
348139.55	6595212.96	0	-62.1049004	2.20891	-2	0	1	0	87.0516968	57.0788994	41.7851982	42	69.5845032	0.0030281	0.0016196	0.0008422	0.0001445
342822.05	6612057.75	0	-61.4277	1.75749	-8	0	0	0	70.6116028	90	22.8472996	24.1868	26.8327999	0.0012763	0.0001333	5.61E-05	1.50E-05
351898.39	6614368.72	0	-47.9258003	2.16468	-1	0	0	0	101.5139999	82.9758987	21.8402996	24.1868	35.1141014	0.0028361	0.0006635	0.000299	9.20E-05
350987.21	6600310.06	0	-74.364502	1.18641	0	0	0	0	283.8770142	268.2109985	8.48528	6.7082	10.8167	0.0036825	0.004253	0.0040486	0.0028881
352182.78	6610689.00	0	-62.5360985	2.5685699	-6	0	0	0	96	88.2835999	72	72.5603027	75.2396011	5.58E-05	6.10E-06	4.40E-06	2.20E-06
350964.63	6600457.96	0	-74.6436996	4.04533	-5	0	0	0	198.3860016	169.0679932	41.6772995	37.589901	37.589901	0.0011931	0.0017779	0.0022577	0.0015674
350121.83	6603757.09	0	-87.0089035	3.30969	-6	0	1	0	127.6320038	107.3310013	75	76.8375015	118.0719986	0.0016173	0.0004116	0.0001282	3.06E-05
354204.08	6614345.65	0	-83.3006973	1.84342	2	0	0	0	136.4589996	261.1380005	128.8600006	132.0339966	152.970993	0.0006803	4.60E-05	2.03E-05	9.10E-06
354394.45	6614328.76	0	-92.1606979	3.5934501	0	0	0	0	172.4669952	337.8169861	75.8946991	81.6088028	183.1719971	0.000423	0.0001029	5.10E-05	1.75E-05
351138.24	6601500.02	0	-56.6516991	1.63943	0	-2	-1	0	46.8614998	40.8044014	30.8868999	36.1248016	39.1152	0.0035956	0.0002224	0.0001755	0.0001151
356425.07	6609859.65	0	-90.1386032	7.4197001	0	1	0	0	42.4263992	23.4307003	23.4307003	25.8069992	34.2052994	0.0056047	0.0011836	0.0006214	0.0001962
355405.93	6612774.88	0	-95.9224014	2.4212401	-7	-3	-1	0	290.6289978	272.3890076	185.151001	187.4459991	191.3430023	0.001011	7.05E-05	4.91E-05	2.13E-05
354702.50	6608560.79	0	-99.0995026	1.02302	-5	0	0	0	192	178.9219971	97.7190018	103.3150024	186	1.60E-05	8.90E-06	4.30E-06	1.00E-06
354854.25	6607835.71	0	-82.7468033	5.5553198	0	1	1	0	66.6108017	84.8527985	59.1693001	39.1152	64.8999023	0.0017185	0.0004234	0.0001959	4.39E-05
350778.16	6608306.21	0	-75.0210037	0.389567	-1	0	0	0	174.5420074	178.4429932	157.0639954	159.7059937	170.4730072	2.42E-05	4.40E-06	3.30E-06	1.70E-06
352766.00	6600667.89	0	-89.282402	1.24942	-7	0	0	0	144.25	164.0149994	122.413002	126.1780014	139.7180023	0.0001396	0.0001172	9.64E-05	1.59E-05
351974.45	6600763.39	0	-63.3935013	2.7739301	-5	0	0	0	130.25	99.8599014	100.2649994	103.2279968	107.4150009	0.00035	9.05E-05	5.27E-05	2.72E-05
340646.29	6615154.69	0	-65.5646973	2.23915	-4	-1	0	0	151.8190002	165.4629974	24.7385998	27	36.2490997	0.000482	5.72E-05	5.89E-05	3.27E-05
354384.71	6614328.26	0	-91.4812012	3.5425601	1	0	0	0	165	331.3609924	72.993103	78.9177017	177.1779938	0.000479	0.0001376	6.91E-05	3.46E-05
354694.78	6609254.84	0	-76.1071014	7.22927	-9	-2	0	0	160.0160065	169.3070068	108.3740005	114.3550034	135.3000031	0.0008991	0.0002479	0.0002191	0.0001191
353969.39	6614357.65	0	-71.1371002	3.86166	0	0	0	0	159.0279999	160.3809967	138	141	148.9459991	2.39E-05	7.20E-06	4.60E-06	1.70E-06
341654.99	6613783.12	0	-49.1041985	5.9225502	0	0	1	0	120	275.1180115	33.1361008	33.1361008	36.1248016	0.0013965	0.0007687	0.0004886	0.0001439
341069.87	6614029.42	0	-57.0252991	1.2719001	0	-1	0	0	172.2850037	280.1430054	40.0250015	40.0250015	96.0468979	0.0027449	0.0002724	0.0001547	4.66E-05
350468.76	6601598.81	0	-73.5758972	1.0172499	-1	0	0	0	125.1760025	125.3199997	85.276001	89.4985962	95.6713028	0.0002497	0.000119	0.0001341	5.89E-05
354799.97	6607982.82	0	-100.538002	1.24764	-13	-4	0	0	102.0439987	119.473999	41.7851982	44.5982018	105.0429993	0.0002398	7.81E-05	3.25E-05	1.10E-05
353899.77	6614362.19	0	-66.5995026	3.63729	0	0	0	0	150	154.0549927	129.1390076	132	138	1.90E-05	3.92E-05	3.25E-05	1.31E-05
352627.26	6604115.59	0	-95.3209991	0.888842	-6	-3	0	0	127.2789993	114.6299973	49.9300003	51.6139984	55.3172989	0.0026485	0.0005713	0.000285	0.0001435
340788.59	6615411.33	0	-41.5643997	4.8007498	4	0	0	0	30.8868999	111.6060028	18	27.6585999	64.6220016	0.0035637	0.0012937	0.0006688	0.0001786
354351.95	6614329.71	0	-89.311203	5.6184301	2	1	0	0	147.5800018	315.2860107	74.2158966	80.0500031	164.125	0.0004392	0.000321	0.0001866	5.58E-05
355546.82	6612757.83	0	-87.6408005	10.9167004	-3	0	0	0	157.6640015	139.845993	87.2065964	99.9049988	144.3119965	0.0011542	0.0012639	0.0012216	0.0006109
351214.27	6601506.59	0	-56.6459999	3.96278	-3	-1	0	0	98.0867004	93.3380966	78.7463989	85.9592972	92.6120987	0.0004668	0.0005462	0.0005444	0.0002816
353393.34	6613062.72	0	-48.3423996	11.7177	-5	-2	0	0	100.6230011	79.202301	46.9574013	48.4664993	61.8465996	0.0007879	0.0003936	0.0002671	0.0001171
354733.24	6609397.08	0	-64.9084015	4.45471	-6	0	0	0	68.4104996	100.2649994	55.1543007	59.3969994	70.0356979	0.0011574	0.0009284	0.0007827	0.0004221
354832.37	6607895.48	0	-90.944603	20.1854	-6	0	0	0	37.589901	107.3310013	30.8868999	31.8903999	39.1152	0.004039	0.001425	0.001231	0.0010609
348219.88	6595215.07	0	-62.948101	0.822953	-5	-2	0	0	58.2495003	25.4557991	13.4164	17.4929008	31.8903999	0.005861	0.0006405	0.0005463	0.0002869
340687.72	6615222.74	0	-59.4805984	4.9861598	-4	0	0	0	132.1360016	133.7949982	33.5410004	36.4966011	55.8031998	0.0012459	6.82E-05	3.52E-05	1.35E-05
352155.71	6600832.84	0	-69.401001	3.0769999	-8	-1	0	0	199.8099976	189.404007	123.3290024	138.1300049	162.25	0.000581	0.0005915	0.0004525	8.48E-05
349576.20	6602909.65	0	-74.1755981	2.1559801	-1	0	0	0	124.7799988	100.6230011	107.3310013	111.3639984	114.0390015	0.0003576	0.0003082	0.000191	5.35E-05
353875.08	6614360.47	0	-64.8977966	3.7137599	0	0	0	0	151.9080048	153	133.154007	134.7330017	139.5890045	1.65E-05	8.90E-06	4.10E-06	1.30E-06
354370.15	6614328.17	0	-90.5950012	3.4071701	1	1	0	0	156.4609985	323.7359924	72	78	170.5780029	0.0004781	0.000402	0.0003455	0.0001786
353698.37	6614347.04	0	-55.8602982	3.0385201	1	0	0	0	239.1170044	226.3560028	217.845993	220.6170044	229.4559937	1.53E-05	5.10E-06	2.20E-06	7.00E-07
353686.43	6614344.11	0	-55.2957993	2.9584601	1	0	0	0	237.3600006	235.8009949	216.3329926	219.1640015	230.5319977	1.38E-05	5.10E-06	3.30E-06	8.00E-07
353844.65	6614358.70	0	-63.0856018	3.6061399	0	0	0	0	162.25	158.3190002	143.279007	146.1100006	149.9400024	1.65E-05	1.24E-05	9.60E-06	3.40E-06
349549.38	6602885.79	0	-74.6428986	0.993882	-1	0	0	0	157.4360046	132.8829956	139.9429932	143.6560059	145.6470032	0.0003567	0.0002094	0.0001599	9.16E-05
351187.19	6601485.41	0	-56.6142998	1.709	-3	-2	0	0	93.1932983	84.8527985	71.3091965	71.3091965	82.7586975	0.0002875	0.0001228	0.0001171	0.0001068
352828.75	6612273.76	0	-72.6239014	0.62096	-6	-2	-1	0	95.6713028	117.3460007	21.6333008	23.4307003	27.6585999	0.0036906	0.0001813	2.66E-05	7.30E-06
355428.89	6612783.30	0	-95.0182037	4.11093	-7	-4	-1	0	268.6799927	250.4600067	187.7579956	190.8009949	202.2720032	0.0029722	0.0003754	7.90E-05	1.09E-05
351934.98	6614261.30	0	-47.4403	0.996685	0	-3	0	0	91.4384995	80.7774963	58.2495003	66.2722015	78.7463989	0.0005172	5.54E-05	3.73E-05	1.94E-05

351923.21	6614280.09	0	-47.4664001	1.41427	0	-2	0	0	90	78.7463989	68.4763031	72.0625	75.5381012	0.0008082	3.79E-05	2.81E-05	1.82E-05
350936.09	6600532.73	0	-73.6928024	0.320668	-9	0	0	0	124.8880005	99.3177032	85.3815002	45	45	0.0003665	0.0003977	0.0003142	0.000254
354532.30	6614347.88	0	-97.2879028	1.39928	0	0	0	0	273.8559875	373.3760071	169.9440002	172.7539978	224.4389954	0.0001047	4.10E-06	3.60E-06	3.40E-06
349611.77	6602919.88	0	-73.7249985	2.51809	-1	0	0	0	89.044899	64.4126968	71.561203	75.1798019	78.2304001	0.0003262	0.0002622	0.0002086	0.0001463
350550.13	6601377.13	0	-72.4469986	2.07605	0	0	0	0	112.4499969	91.2414017	93.3380966	97.5807037	99.7246017	0.0003464	0.000151	0.0001335	6.97E-05
351219.36	6605580.44	0	-74.9832993	1.04316	-4	-4	-1	0	99	99.7246017	81.939003	86.5332031	90	0.0027211	0.0005186	0.0002296	8.91E-05
340635.91	6615148.19	0	-66.0229034	2.4678199	-3	-1	0	0	153.1179962	166.9790039	37.9473	39.4588013	45.891201	6.85E-05	3.59E-05	2.46E-05	1.10E-05
353971.16	6614357.10	0	-71.1371002	3.86166	0	0	0	0	159.0279999	160.3809967	138	141	148.9459991	2.39E-05	7.20E-06	4.60E-06	1.70E-06
341051.51	6613980.43	0	-56.6086998	3.81002	0	0	0	0	191.4600067	229.9649963	48.3735008	51.3516998	54.7448997	0.0027464	0.0004038	0.0003533	0.0001692
349690.60	6616781.09	0	-73.8826981	22.7630005	12	6	2	1	81.0554962	180.6239929	44.2944984	57	60	0.0018358	0.0002406	0.0001603	0.0001025
350827.37	6608364.66	0	-74.4988022	1.04189	-2	0	0	0	100.8460007	106.3199997	84.4807968	86.3770981	97.7190018	6.92E-05	1.47E-05	5.40E-06	2.60E-06
351880.33	6614409.01	0	-48.2943001	0.955433	0	2	1	1	133.154007	115.7630005	60	63	74.2764969	0.0017762	0.000513	0.0001509	2.12E-05
350509.35	6603551.36	0	-89.8264008	1.40748	-6	0	0	0	110.6350021	85.9592972	89.0954971	91.2414017	93.3380966	0.0007598	0.0007032	0.0005923	0.0004352
352080.94	6600809.07	0	-67.6903992	0.999908	-7	0	0	0	198.9299927	214.7669983	127.6320038	132.8829956	188.3079987	0.0004135	0.0002006	0.0001379	2.90E-05
342167.99	6613916.05	0	-31.8106995	3.28109	-2	-11	0	0	65.5210037	51.2639999	41.7851982	44.5982018	57.0788994	0.0001664	2.35E-05	9.30E-06	2.60E-06
354045.85	6614350.36	0	-75.9859009	3.5775399	0	0	0	0	185.223999	189.8549957	126.3209991	165.1089935	182.5079956	6.89E-05	2.19E-05	1.36E-05	2.60E-06
353375.32	6609569.81	0	-75.2463989	2.2088499	-2	1	0	0	237.6069946	328.4689941	105.5130005	109.2020035	188.8090057	8.71E-05	1.67E-05	1.25E-05	6.30E-06
351224.71	6601507.55	0	-56.6007996	4.9211702	-2	0	0	0	99.9049988	100.6230011	75.9539032	80.7774963	96.6074982	0.000564	0.000905	0.0007749	0.0004531
341624.21	6613747.37	0	-53.4109001	2.08255	-2	0	0	0	152.970993	295.4349976	74.0944977	74.0944977	76.6615982	0.000903	7.40E-06	2.10E-06	4.00E-07
352838.12	6600637.52	0	-89.8962021	0.736509	-3	0	0	0	177.2290039	150.7480011	159.1130066	162.25	165.2449951	0.0003254	0.0001014	0.000123	9.50E-05
352693.99	6600691.13	0	-88.2104034	0.948845	-4	-1	0	0	93.3380966	117.1539993	72.2496033	78.7463989	87	0.0003593	0.000165	0.0002029	0.000154
352702.90	6612233.48	0	-69.5027008	2.8979199	-9	-5	-2	0	55.3172989	48.4664993	21.8402996	32.3110008	65.5210037	0.0034298	0.0007283	0.0004755	0.000191
354175.97	6614355.33	0	-82.0322037	6.0171599	2	0	0	0	146.3860016	236.6199951	128.8600006	135.8309937	141.0319977	0.0006708	0.001491	0.0015512	0.0015479
352657.69	6600703.06	0	-87.4029007	1.92769	-7	-2	0	0	72	82.9758987	45.7929993	57	60	0.0015357	0.0004933	0.0003412	0.0001311
355949.50	6613431.90	0	-105.027	7.4261298	-1	0	0	0	81	55.3172989	57.7061996	60.0750008	63.0713997	0.0007049	0.0002301	0.0001341	8.37E-05
352740.78	6603921.78	0	-96.7717972	2.76665	-1	0	0	0	296.2109985	271.2799988	99.0454025	99.1816025	102.0439987	0.0011866	0.0010355	0.0008475	0.0004798
352209.20	6610728.71	0	-63.0509987	2.66185	-5	0	0	0	129.0350037	126.1429977	106.4049988	109.2020035	111.4850006	6.06E-05	8.90E-06	5.80E-06	5.50E-06
350842.80	6608373.69	0	-74.2754974	0.821077	-2	0	0	0	87.2065964	93.9627991	69.7781982	72.4982986	85.3287964	0.0001101	2.49E-05	9.70E-06	4.40E-06
350594.32	6601349.98	0	-71.5091019	1.79326	-1	-1	0	0	111	90.2497025	93.9627991	96.8401031	99.7246017	0.0003232	0.0001264	6.43E-05	2.22E-05
354684.76	6609218.10	0	-79.0800018	5.8857899	-10	-4	-1	0	156.6049957	164.3439941	75	80.7774963	101.2030029	0.0021066	0.0015864	0.001225	0.0006489
355002.83	6614919.99	0	-130.457993	1.86537	-16	-7	-2	0	112.7300034	96.0468979	10.8167	60	60	0.0036715	0.0012407	0.0003756	6.87E-05
351252.76	6601477.38	0	-55.0177002	3.0186	0	0	0	0	82.9758987	81.0554962	69.2603989	71.561203	78.7463989	0.0007051	0.0003016	0.0001475	0.0001051
351229.10	6601476.76	0	-55.2924004	1.85341	-1	0	0	0	106.5319977	105.0429993	92.4175034	92.6120987	101.8679962	0.0004917	0.0002726	0.0002735	0.0002084
354360.68	6614328.72	0	-89.9355011	5.5357299	1	1	0	0	151.8190002	319.4119873	72.5603027	78.5175018	167.1410065	0.0004576	0.0004191	0.000306	0.0001624
352845.38	6612276.61	0	-72.8219986	0.959736	-5	-1	-1	0	104.1389999	128.4060059	34.2052994	34.9856987	37.589901	0.0030285	0.0002531	7.44E-05	1.61E-05
352674.55	6604014.97	0	-95.9412003	0.391868	-3	0	0	0	191.9299927	175.3910065	162.3609924	163.7680054	126.1780014	0.0007522	0.0007017	0.0006117	0.0003067
356424.85	6609860.55	0	-89.7545013	7.6198702	0	1	0	0	40.8044014	21.2131996	21.2131996	24.1868	31.8903999	0.006321	0.0013437	0.0005974	9.76E-05
353618.71	6611696.94	0	-81.2285995	1.4651	-2	-2	-1	0	33.5410004	84.2139969	16.9706001	25.8069992	37.9473	0.0058272	0.0012844	0.000605	0.0001739
350187.63	6603794.20	0	-86.7141037	6.6641502	-1	-3	0	0	85.9068985	66	68.5419998	71.3091965	78	0.0018969	0.0007104	0.0002524	9.95E-05
340796.40	6615432.46	0	-39.0358009	4.81919	6	0	0	1	50.9117012	92.6606979	6	12.7278996	51.0881996	0.0039025	0.0025665	0.0016107	0.0007526
352699.29	6600688.37	0	-88.3543015	2.03368	-4	-1	0	0	95.6713028	123.0370026	74.2764969	80.610199	89.4985962	0.0003021	0.0001554	0.0001327	4.05E-05
351252.00	6601477.44	0	-55.0177002	3.0186	0	0	0	0	82.9758987	81.0554962	69.2603989	71.561203	78.7463989	0.0007051	0.0003016	0.0001475	0.0001051
342845.61	6612072.20	0	-60.7285004	1.95364	-11	-1	0	0	91.3892975	114.9830017	48.8364983	50.9117012	53.0754013	0.0001224	5.70E-05	5.16E-05	2.75E-05
350680.31	6601295.57	0	-70.6560974	2.6651001	-6	-4	0	0	89.4985962	60.7453995	69.9713974	72.6222992	76.6615982	0.0006343	0.0002927	0.0002077	0.0001345
352858.58	6600627.76	0	-89.8345032	0.987518	-2	0	0	0	168.1069946	141	150	153	156	0.0004168	0.0002423	0.0002649	0.0002181
352781.66	6600661.95	0	-89.4223022	1.76954	-7	0	0	0	157.8919983	174.026001	136.0619965	139.7180023	153.5870056	0.0001638	0.0001091	8.61E-05	4.20E-05
352165.80	6610668.56	0	-62.1049004	2.14468	-6	-1	0	0	82.3771973	72.0625	57	57.0788994	60.0750008	0.0001287	4.98E-05	1.66E-05	6.60E-06
352824.05	6600644.76	0	-90.0588989	0.438254	-5	0	0	0	187.5420074	161.8049927	169.3070068	172.6759949	175.6470032	0.0002529	0.0002477	0.0001578	6.60E-05
348086.60	6595210.63	0	-63.6032982	3.8048501	0	-1	0	0	88.2326965	57.9396019	13.4164	63.0713997	66.4077988	0.003118	0.0015239	0.0008191	0.0002564
352657.26	6600703.24	0	-87.2565994	2.19344	-7	-2	0	0	69	80.0500031	43.2666016	54	57	0.0017734	0.0007564	0.0006249	0.0003307
353669.16	6614344.69	0	-54.4586983	2.48756	1	0	0	0	231.6029968	237.1710052	211.026001	213.9279938	225.5590057	1.41E-05	3.10E-06	2.70E-06	2.10E-06
351968.04	6614232.47	0	-45.6679993	3.42925	0	-5	0	0	95.3414993	78.2304001	43.2666016	46.8614998	77.8844986	0.0001162	1.82E-05	1.26E-05	1.10E-05
351243.24	6601499.10	0	-56.2103996	2.36129	-1	0	0	0	91.4384995	93.9627991	81.2219009	81.8841019	93.1932983	0.0006648	0.000371	0.0002104	9.13E-05
350437.68	6603536.69	0	-89.1289978	2.20753	-9	-4	0	0	56.0446014	24.7385998	36.1248016	38.1837997	40.3609009	0.0017478	0.000972	0.0004237	4.15E-05
353387.69	6613049.50	0	-51.2543983	12.7888002	-7	-2	0	0	114.0390015	92.4175034	37.1080017	39.4588013	65.5210037	0.0009724	0.0002009	0.0001812	0.0001256
352031.31	6600780.47	0	-66.0245972	2.1428101	-8	0	0	0	189.2140045	158.3190002	136.8209991	141.0319977	163.9329987	0.0002824	0.0001383	0.0001137	4.13E-05
353953.98	6614361.08	0	-70.1026001	3.9345	0	0	0	0	154.9869995	156.1150055	132.4420013	134.7330017	144.2810059	1.67E-05	2.60E-06	1.90E-06	2.00E-06
355571.87	6613535.59	1	-53.4040985	20.3341999	12	0	-2	-3	12	0	0	0	0	0.0367556	0.0395017	0.0291191	0.0143968
349193.17	6611335.71	1	-60.2401009	11.7676001	19	3	1	0	10.8167	0	0	0	3	0.0412096	0.0128527	0.0079025	0.0039493
351709.43	6606713.01	1	-51.7806015	10.6744003	14	12	8	4	0	0	0	0	3	0.0679532	0.0182197	0.0082342	0.0023974
349571.44	6614187.17	1	-41.8311005	14.7446003	24	8	4	0	12	0	4.24264	6	10.8167	0.0343688	0.0037599	0.0018123	0.0007529
351260.86	6598407.12	1	-44.3502007	14.8652	21	2	-1	1	4.24264	0	0	0	0	0.114979	0.0946005	0.0762978	0.0525458
349157.99	6611411.00	1	-51.8524017	11.5860004	29	6	-1	1	39.1152	0	3	6	9.4868298	0.0249878	0.0031354	0.0011627	0.0003005

353557.35	6611474.78	1	-67.0042038	16.0305004	1	-1	-1	-2	15	0	0	0	0	0.0521296	0.0250272	0.020741	0.0098729
349554.84	6614130.32	1	-41.2538986	24.6914997	31	12	2	0	6	0	0	3	4.24264	0.0397374	0.011381	0.0039364	0.0006499
348045.87	6595215.87	1	-65.6804962	5.2811999	0	-3	0	0	54.0833015	37.1080017	34.2052994	36.2490997	40.2491989	0.0025863	0.0022675	0.0014051	0.0006014
348378.36	6595022.69	1	-31.8117008	27.6963997	27	18	3	-1	6.7082	0	0	0	0	0.0935273	0.0142121	0.0118877	0.0090735
353601.71	6611575.78	1	-76.2873001	6.4806099	-2	-1	-5	-3	12.7278996	0	0	0	0	0.0393148	0.0332004	0.0276021	0.0136353
351389.11	6598333.57	1	-57.8578987	12.9108	9	2	-3	0	12.3692999	0	0	0	3	0.0360628	0.0147754	0.0091174	0.0026632
355702.56	6609901.79	1	-46.1170006	15.2663002	8	6	1	0	24.7385998	8.48528	0	3	3	0.0173129	0.0061989	0.0047516	0.0021042
350542.71	6604592.55	1	-56.8377991	37.3368988	11	3	1	0	6	0	0	0	3	0.0373793	0.0220533	0.0133087	0.00355
350477.12	6604563.70	1	-46.9392014	28.7348003	16	9	9	5	0	0	0	0	0	0.0277879	0.0358955	0.0225287	0.01247
351128.96	6599524.21	1	-73.7946014	5.3859801	-10	-14	-8	-3	21.2131996	0	0	0	3	0.060948	0.0266683	0.0151648	0.0044754
353569.52	6611325.15	1	-50.4499016	10.2472	10	11	2	0	12	0	0	0	0	0.0590671	0.0380201	0.0257342	0.0112449
342491.53	6610259.86	1	-71.2265015	5.4597402	3	0	0	0	85.8021011	123.3290024	28.3019009	33.1361008	36.2490997	0.0024904	0.0011769	0.0007551	0.0003811
351292.51	6598772.38	1	-45.7112007	35.5782013	15	16	11	5	0	0	0	0	0	0.0441316	0.0443138	0.0265105	0.0055062
355841.71	6613461.91	1	-86.5899963	15.1869001	0	-1	1	1	9	18.9736996	0	3	9	0.0090501	0.0062084	0.0041095	0.0015921
350916.71	6599416.25	1	-50.9875984	9.9768896	11	3	0	0	21.2131996	36.2490997	9	12	13.4164	0.0079684	0.0017278	0.0011866	0.0004271
353033.25	6611495.28	1	-53.2573013	13.9087	2	1	2	0	63.0713997	55.0727005	3	4.24264	9.4868298	0.0134147	0.0039033	0.0029	0.0011466
351337.83	6598305.06	1	-54.0904007	16.6534996	12	8	3	1	16.1555004	0	0	0	0	0.0673165	0.0259793	0.0176127	0.0064623
352092.73	6604457.37	1	-54.9295998	22.3644009	8	7	3	1	10.8167	0	0	0	4.24264	0.021017	0.0130635	0.0066932	0.0012888
351157.50	6599540.15	1	-66.7734985	7.9365602	-2	-5	0	2	10.8167	0	3	6	12	0.0274125	0.0042933	0.0032588	0.0018223
352571.03	6604181.23	1	-84.7899017	8.2114801	-1	2	1	1	55.1543007	97.6728973	12.7278996	15	17.4929008	0.0049361	0.002139	0.0012784	0.000698
351281.84	6599595.32	1	-68.927002	8.2304096	0	-3	0	1	39	12	20.1245995	21.8402996	30	0.0067853	0.0010731	0.0005212	0.0003876
351644.50	6604752.03	1	-65.6255035	11.8511	0	-9	-8	-2	39	0	0	0	12	0.0248912	0.0116943	0.0082686	0.0044832
352021.64	6607124.63	1	-91.331398	21.3262997	-14	-10	-2	-1	9	0	0	0	0	0.0247291	0.0233563	0.0189419	0.0094096
352042.70	6604006.54	1	-71.0895996	9.02561	5	5	4	2	3	6.7082	0	0	3	0.0177757	0.0200276	0.0131897	0.0046089
351269.12	6599585.79	1	-67.4598007	12.4032001	0	-1	-1	0	31.3209	3	12	15	21.6333008	0.0172979	0.0009618	0.0006287	0.0002744
353557.58	6611345.32	1	-49.2340012	27.8603992	11	11	3	0	6.7082	0	0	0	0	0.0638001	0.0419462	0.0346751	0.0190325
355048.72	6615059.75	1	-99.1763	9.8135004	5	9	5	1	21.2131996	64.6220016	8.48528	6.7082	16.1555004	0.0105715	0.0033186	0.0021844	0.000853
353598.87	6611623.39	1	-70.8622971	11.2343998	5	4	3	1	15	12	6.7082	10.8167	15.2971001	0.0095878	0.0010739	0.0005373	0.0001894
354817.37	6607940.07	1	-100.051003	2.5739501	-14	-6	-3	0	63.5689011	115.802002	13.4164	30.1495991	66.4077988	0.0080907	0.0006518	0.0003428	0.0001701
354972.55	6607446.70	1	-73.7900009	14.7301998	0	-7	-3	-1	15	0	0	0	6.7082	0.0361624	0.0111704	0.0068172	0.0022069
351335.89	6601495.81	1	-50.9399986	16.8673992	9	5	0	0	24.1868	13.4164	18	21	21.8402996	0.0065398	0.001851	0.000887	0.0003022
352114.38	6604490.36	1	-68.5898972	18.6786003	-4	-7	-7	0	36.6197014	0	0	0	6	0.0300036	0.0081692	0.005479	0.0026406
351332.70	6601495.43	1	-51.6001015	16.6040001	8	5	0	0	26.8327999	15	21	24	24.7385998	0.0055605	0.0023208	0.001466	0.0003608
351900.33	6614339.86	1	-45.7408981	1.66213	0	1	2	1	96.1873016	81	4.24264	13.4164	36.2490997	0.0053304	0.0038784	0.0018684	0.0005183
350701.72	6614014.61	1	-48.7118988	16.0783997	5	0	0	0	36	30.8868999	0	4.24264	6.7082	0.0118945	0.0066689	0.0021555	0.0006593
351320.72	6601492.81	1	-53.0494995	8.73347	6	3	0	0	28.3019009	21.2131996	21.2131996	25.8069992	28.3019009	0.00496	0.0013788	0.0004312	0.0001647
351347.21	6601497.81	1	-49.0646019	13.0438995	12	7	1	0	17.4929008	6.7082	6	9	9.4868298	0.014038	0.0018098	0.0012904	0.0006049
341023.09	6613907.93	1	-54.6911011	6.6444802	2	2	1	0	116.6920013	156	21.2131996	21.2131996	23.4307003	0.0022298	0.0012385	0.0010424	0.0004997
352092.74	6604457.59	1	-54.9295998	22.3644009	8	7	3	1	10.8167	0	0	0	4.24264	0.021017	0.0130635	0.0066932	0.0012888
347004.19	6614911.95	1	-40.4202995	17.6401005	30	13	8	3	0	0	0	3	8.48528	0.0605606	0.0080025	0.0045307	0.003197
355003.17	6607505.99	1	-62.6548996	7.8172202	11	6	0	-1	15	0	0	0	3	0.0783563	0.0224084	0.0110306	0.0038128
350975.25	6599433.17	1	-38.9870987	13.7038002	24	11	7	5	0	0	0	0	0	0.0303736	0.068013	0.0832779	0.0653531
348332.55	6595218.65	1	-61.466301	11.7040005	0	-3	0	0	55.3172989	37.589901	33	33	39.4588013	0.0039002	0.0006279	0.0004721	0.0003082
352028.77	6604340.30	1	-69.964798	20.7929001	-6	-8	-2	0	21.2131996	0	6	9	12	0.0213897	0.0017952	0.0013666	0.0006512
349889.89	6603109.91	1	-50.3594017	20.0093002	12	8	1	0	16.9706001	0	0	0	0	0.0338748	0.0231952	0.0195057	0.0114416
354973.63	6607448.64	1	-72.5639038	20.6464996	0	-6	-2	0	12.3692999	0	0	0	6.7082	0.0356372	0.0112549	0.0074138	0.0033469
354340.89	6608538.02	1	-53.5791016	13.4180002	10	0	0	1	23.4307003	9.4868298	4.24264	6.7082	12.3692999	0.013351	0.0032904	0.0021326	0.0008186
350568.04	6604602.48	1	-48.3445015	4.6964202	20	12	14	6	0	0	0	0	0	0.0906881	0.021979	0.0147474	0.007537
355777.15	6609933.57	1	-61.6463013	31.493	-1	-3	-2	-2	9	0	0	0	0	0.025891	0.0160069	0.014473	0.0084409
350809.45	6599336.69	1	-64.5707016	11.4769001	-3	-1	0	0	45.0998993	90.2497025	13.4164	16.1555004	21.6333008	0.0058228	0.002974	0.0022852	0.0009927
350810.14	6599342.45	1	-64.6199036	14.6573	-3	-1	0	1	45.0998993	92.0271988	10.8167	13.4164	16.9706001	0.0060697	0.003424	0.002585	0.0010452
351273.49	6601486.38	1	-54.9220009	5.40237	1	0	0	0	65.5210037	61.1882019	51.2639999	56.6039009	63.285099	0.0009131	0.0002675	0.0001637	5.19E-05
351351.19	6605677.12	1	-41.1734009	13.4396	26	18	17	6	0	0	0	0	0	0.112074	0.0444872	0.0292153	0.0110697
355616.48	6613520.92	1	-56.7752991	15.0560999	9	0	-4	-2	24	0	0	0	3	0.048906	0.0214208	0.0129066	0.0041666
354975.07	6607451.24	1	-71.2938004	26.2553997	2	-5	-1	0	9.4868298	0	0	0	6	0.0349754	0.0107611	0.0073098	0.0032674
351265.22	6598462.55	1	-45.7879982	27.2800007	17	-1	-4	-5	10.8167	0	0	0	0	0.0768066	0.114066	0.117331	0.074006
354988.60	6607475.71	1	-65.5737991	11.8519001	7	0	1	0	6.7082	0	0	0	0	0.0504915	0.04425	0.0294917	0.013653
353570.59	6611531.44	1	-65.9910965	20.3453007	5	3	2	0	9.4868298	0	0	0	6.7082	0.0297633	0.0105036	0.0056221	0.0025765
352114.38	6604490.36	1	-68.5898972	18.6786003	-4	-7	-7	0	36.6197014	0	0	0	6	0.0300036	0.0081692	0.005479	0.0026406
350964.81	6599427.90	1	-45.0704002	11.9709997	18	5	1	0	6.7082	0	0	0	0	0.0232493	0.0174426	0.0143905	0.007144
350739.32	6604666.77	1	-71.9017029	29.9080009	7	8	8	6	0	0	0	0	0	0.0661147	0.0506092	0.0379992	0.0187364
349553.55	6614172.89	1	-44.0791016	18.9731998	25	8	0	0	6.7082	0	0	0	4.24264	0.0263772	0.0116575	0.0056888	0.001417
351621.61	6604833.62	1	-40.8450012	19.6599007	23	18	7	3	0	0	0	0	0	0.0311121	0.0229723	0.0242789	0.0167491

349569.04	6614017.84	1	-26.0365009	7.2560301	56	29	17	8	0	0	0	0	0	0.110001	0.0567263	0.0353969	0.0133464
352130.10	6604213.92	1	-76.7960968	8.5729799	-13	-6	-3	-1	23.4307003	0	6	9.4868298	12.7278996	0.0266284	0.0016465	0.0009368	0.0003744
350737.40	6604666.38	1	-71.9017029	29.9080009	7	8	8	6	0	0	0	0	0	0.0661147	0.0506092	0.0379992	0.0187364
348356.34	6594881.99	1	-69.9007034	18.5554008	-12	-8	-5	-7	12.7278996	0	0	0	0	0.0802057	0.107907	0.0876154	0.0436
354368.56	6608542.07	1	-61.2541008	20.7206001	5	-2	-4	0	37.1080017	0	4.24264	6.7082	15	0.0204949	0.0035473	0.0020102	0.0007377
347933.08	6595212.19	1	-70.5744019	5.4898901	0	0	-4	-1	24.1868	0	0	4.24264	6.7082	0.0486996	0.0052788	0.0018013	0.0005721
342880.94	6611009.62	1	-66.2126999	2.1431701	0	-2	-2	0	39	75.0599976	18	24	27	0.0101511	0.001301	0.0005894	0.0001876
355177.64	6615337.43	1	-57.7593994	11.0444002	38	14	5	1	9.4868298	0	3	6	10.8167	0.0203429	0.0047712	0.0023723	0.0009323
349204.89	6611293.49	1	-67.0208969	10.0495005	11	1	0	1	6.7082	3	0	4.24264	8.48528	0.0194411	0.0051193	0.0029142	0.0019376
342703.52	6611159.09	1	-68.6830978	13.0214996	2	-1	-1	0	42.4263992	51.0881996	6.7082	10.8167	39.1152	0.0067702	0.0020146	0.000494	0.0001556
350362.61	6602821.70	1	-40.5760002	14.2791004	26	15	3	2	3	0	0	3	6	0.0425938	0.0076656	0.0048316	0.0022733
351039.34	6599474.49	1	-48.3899002	25.9927006	12	7	0	0	6.7082	3	0	0	0	0.0193852	0.0253142	0.0184885	0.0102813
353659.98	6614587.43	1	-51.0043983	8.0977802	-10	-8	-2	0	59.774601	48	6	9	13.4164	0.0055857	0.0023063	0.0015591	0.0007585
352149.88	6604521.64	1	-65.8588028	21.9568005	-2	0	-2	-2	13.4164	0	0	0	0	0.0393074	0.0186864	0.0146948	0.007208
350353.81	6603347.82	1	-70.4029007	9.6358099	7	-3	-3	0	51.2639999	45	18.2483006	36	36.1248016	0.0051683	0.0006159	0.0002675	8.29E-05
344117.62	6610338.13	1	-68.5867996	26.1564007	8	10	6	2	3	0	0	0	0	0.0314616	0.0325236	0.0258263	0.0124896
355898.67	6612777.36	1	-68.7890015	9.4819098	12	6	3	1	12.3692999	0	0	0	3	0.0319307	0.0107539	0.0083069	0.0046016
353581.31	6611302.89	1	-54.3646011	21.9216995	7	9	1	0	13.4164	0	0	0	0	0.0461055	0.0441786	0.0358363	0.0149674
351378.10	6601465.67	1	-47.3432007	7.8698602	15	9	-1	-2	12	0	0	0	3	0.0461697	0.0350138	0.0187446	0.003141
355767.93	6612768.57	1	-66.0190964	10.4222002	16	4	0	-3	10.8167	0	0	0	0	0.067625	0.0860913	0.0678267	0.0279678
351259.20	6605612.16	1	-69.0423965	7.37398	0	-3	0	0	52.3927002	59.3969994	34.2052994	36.2490997	45.0998993	0.0012962	0.0010287	0.0010128	0.0004823
343756.39	6611058.74	1	-41.5474014	11.618	11	0	-1	0	33.5410004	51.0881996	0	6	9	0.0148646	0.0063184	0.001968	0.0002252
350484.19	6604566.50	1	-48.4754982	26.8561993	15	8	8	4	0	0	0	0	0	0.0285302	0.035147	0.0233343	0.0053437
349157.71	6611430.21	1	-49.9584999	10.0105	30	9	0	2	45.6945992	4.24264	0	3	6	0.0178491	0.0069404	0.0032601	0.0011231
350883.40	6599394.24	1	-54.8381004	11.4243002	5	2	0	0	24.1868	46.8614998	4.24264	6.7082	8.48528	0.008118	0.0038884	0.004148	0.0040877
349578.98	6614061.63	1	-38.2375984	35.9045982	37	14	4	0	9	0	0	3	4.24264	0.0621998	0.0126836	0.0048937	0.0016158
351171.17	6599539.18	1	-66.3970032	2.2170701	-1	-4	0	-1	18	0	0	4.24264	8.48528	0.0369722	0.0072922	0.0024798	0.0013474
351767.58	6606705.69	1	-58.8939018	18.8295994	7	6	2	0	10.8167	0	0	0	4.24264	0.0596755	0.0228381	0.0075852	0.0038646
351333.51	6601495.55	1	-51.6001015	16.6040001	8	5	0	0	26.8327999	15	21	24	24.7385998	0.0055605	0.0023208	0.001466	0.0003608
349866.99	6611490.96	1	-52.9477997	25.8451996	14	7	2	3	0	0	0	0	4.24264	0.027395	0.0171103	0.0069499	0.0010873
351244.91	6605600.66	1	-71.8751984	10.7546997	-2	-4	0	0	67.4166031	72	49.4772987	52.4785995	58.9406013	0.002833	0.0003017	0.0002525	0.0001066
354974.17	6607449.62	1	-72.5639038	20.6464996	0	-6	-2	0	12.3692999	0	0	0	6.7082	0.0356372	0.0112549	0.0074138	0.0033469
351339.31	6601495.91	1	-50.3669014	19.2966995	10	6	1	0	21.6333008	12.3692999	15	18	18.9736996	0.0080855	0.0017649	0.000957	0.0003056
352419.67	6600815.25	1	-54.460701	13.9348001	15	16	7	2	6	0	0	0	3	0.0405025	0.0116935	0.007588	0.0045412
353847.66	6614677.51	1	-44.0217018	17.3843002	8	0	-3	-1	12	0	0	0	0	0.0396165	0.022415	0.0147819	0.0058065
344105.68	6610352.47	1	-65.3080978	21.8775005	10	12	10	3	0	0	0	0	3	0.0370158	0.0163651	0.0102661	0.0044619
354168.53	6614833.65	1	-60.5644989	4.30651	17	1	0	-1	12.3692999	0	0	0	3	0.0263919	0.0210457	0.0108926	0.0024394
351030.15	6599480.77	1	-50.2130013	19.2672997	11	6	0	0	9	12	0	0	0	0.0161974	0.0147288	0.0104816	0.0057143
343508.66	6610748.47	1	-65.1164017	14.3188	4	3	0	0	48	40.8044014	20.1245995	23.4307003	30.1495991	0.0066893	0.0001813	0.000122	8.48E-05
351532.07	6605029.73	1	-60.2789001	33.0896988	3	-3	-1	0	16.9706001	0	0	0	0	0.0354916	0.0134079	0.0116209	0.0082534
350322.70	6602896.20	1	-48.5480995	2.5381601	13	0	-1	0	29.6984997	20.1245995	4.24264	10.8167	13.4164	0.0111166	0.0029875	0.0022918	0.0009101
351524.88	6598277.73	1	-68.373497	25.4687996	6	5	6	1	3	0	0	0	0	0.0448518	0.0247164	0.0221313	0.0126886
351524.56	6605048.82	1	-52.4530983	32.5217018	11	4	8	1	3	0	0	0	0	0.0682812	0.0182276	0.0149432	0.0083069
353638.69	6609519.29	1	-46.4227982	12.3652	12	0	1	1	90	78.7463989	0	3	3	0.0015153	0.0053529	0.004738	0.0019418
347938.42	6595213.88	1	-70.2102966	9.8702898	0	0	-4	-2	21.8402996	0	0	3	6	0.0474362	0.0090685	0.004121	0.0016204
351873.54	6614418.95	0	-48.6823997	7.2170801	0	2	2	1	144.996994	128.1600037	69	72.5603027	87	0.00142	0.0019602	0.0014601	0.0006428
352707.05	6612235.40	0	-69.5521011	2.4730401	-9	-5	-2	0	54.7448997	47.4342003	24.7385998	35.1141014	64.7611008	0.0029718	0.0005443	0.0003279	0.0001166
354699.86	6609266.32	0	-75.5112	4.29777	-9	-2	0	0	163.9329987	173.0659943	120.1500015	126.1429977	147.121994	0.0006753	0.0002839	0.0001941	6.71E-05
354183.79	6616543.20	0	-103.872002	18.3887005	-3	-1	0	0	95.7182999	111.4850006	33.9411011	36.1248016	79.202301	0.0013276	0.0001895	9.07E-05	1.76E-05
350978.82	6600333.13	0	-74.9840012	5.5475898	0	0	0	0	262.9920044	247.1320038	27	15	12	0.0028303	0.0013677	0.0013435	0.0011939
352650.81	6604062.17	0	-95.4654999	2.5221	-4	0	0	0	153.5870056	141.2230072	108.7060013	110.1449966	113.2080002	0.0005283	0.0003157	0.0002989	0.0001447
353723.07	6614367.69	0	-56.7345009	3.00632	0	0	0	0	217.2050018	195.576004	192.5850067	195.4380035	200.552002	1.84E-05	8.90E-06	2.40E-06	4.00E-07
340738.33	6615327.58	0	-51.9294014	8.05861	-6	-1	0	0	68.4104996	141.2230072	30.594101	32.3110008	45.7929993	0.0010083	4.99E-05	3.24E-05	1.57E-05
340637.23	6615148.97	0	-65.8522034	2.19716	-3	-1	0	0	153.9380035	165.0820007	34.2052994	36.1248016	43.6806984	7.62E-05	4.29E-05	2.84E-05	6.60E-06
350067.66	6603730.72	0	-89.0111008	0.71308	-8	-1	0	0	149.3079987	145.3990021	115.4120026	93.9627991	96.8401031	0.0006675	0.0001854	9.57E-05	2.63E-05
341798.29	6613928.64	0	-34.3137016	2.1988699	0	3	2	0	82.9758987	157.0350037	12.7278996	10.8167	16.1555004	0.0038852	0.0016294	0.0011901	0.0010375
344376.41	6610081.14	0	-91.8979034	19.3395996	7	3	1	0	36.6197014	27.6585999	24.1868	37.589901	48.8364983	0.0062786	0.0029889	0.0018079	0.0006249
351893.82	6614381.33	0	-48.2360992	1.05338	-1	0	0	0	112.7300034	93.0484009	34.2052994	36.4966011	47.4342003	0.0020268	7.83E-05	5.06E-05	1.65E-05
354102.21	6614365.64	0	-78.7417984	2.7412901	0	0	0	0	200.1920013	189.4759979	116.6920013	147.7330017	150.3600006	2.43E-05	8.00E-06	3.00E-06	2.90E-06
353599.74	6611749.92	0	-80.922699	1.1273	-1	0	0	0	68.4763031	140.0709991	53.6655998	56.3648987	59.0931015	3.17E-05	1.40E-05	3.80E-06	8.00E-07
350773.43	6608301.74	0	-75.0541	0.185336	0	0	0	0	181.2460022	185.151001	163.7680054	166.4120026	177.1779938	2.03E-05	8.70E-06	4.40E-06	8.00E-07
352751.59	6612252.98	0	-68.4642029	1.81181	-6	-1	1	1	73.5458984	64.7611008	26.8327999	29.5466003	33.5410004	0.0022857	0.0007983	0.0004676	0.0001636
355553.11	6612756.10	0	-86.7457962	9.9542198	-2	0	0	0	152.0850067	134.3320007	82.7586975	96.0468979	138.7160034	0.0010345	0.0013375	0.0013387	0.0006387

352248.15	6600856.09	0	-69.6289978	5.55654	-7	-2	0	0	137.673996	106.5319977	99.7246017	107.2050018	109.4899979	0.0012264	0.000275	0.00027	0.0001451
352846.52	6600633.47	0	-89.9072037	0.880043	-3	0	0	0	174	147.121994	156	159	162	0.0003536	0.0001422	8.76E-05	5.00E-05
354821.34	6607934.41	0	-99.6875992	4.89077	-14	-6	-3	0	59.0931015	117.1539993	10.8167	33.1361008	61.8465996	0.0083073	0.0012675	0.0005959	0.0001379
342825.20	6612060.44	0	-61.3091011	1.96698	-9	0	0	0	74.2158966	93.0484009	26.8327999	28.3019009	30.8868999	0.0008642	4.90E-05	2.32E-05	1.34E-05
353933.69	6614362.36	0	-68.6986008	3.9798801	0	0	0	0	151.076004	156	129.3139954	132.1360016	141.8910065	1.23E-05	6.40E-06	3.90E-06	2.20E-06
352839.38	6612274.52	0	-72.7274017	0.707067	-5	-1	-1	0	101.822998	122.413002	29.5466003	30.8868999	34.2052994	0.0033101	9.18E-05	2.91E-05	7.30E-06
355453.55	6612790.20	0	-92.2382965	13.3486004	-5	-2	-1	0	241.1970062	222.9909973	160.1000061	163.2180023	221.7769928	0.0026438	0.0010875	0.0006711	0.0002925
351143.94	6601499.51	0	-56.7462006	2.1868801	0	-1	-1	0	50.9117012	44.5982018	34.2052994	40.2491989	44.2944984	0.0023602	0.0001909	0.0001504	5.04E-05
353449.20	6609573.82	0	-76.5565033	3.27033	-8	-4	-1	0	214.7039948	257.1090088	36.1248016	39.1152	144.996994	0.0004583	5.72E-05	4.04E-05	3.36E-05
351930.48	6614268.56	0	-47.4356003	0.834441	0	-2	0	0	92.4175034	82.3771973	63.285099	72	79.8812027	0.000629	3.28E-05	2.32E-05	1.84E-05
349548.65	6602885.33	0	-74.6641998	0.118589	0	0	0	0	160.0160065	135.5319977	142.5240021	146.2940063	143.121994	0.0003596	0.0002202	0.0001745	7.36E-05
352231.98	6600854.45	0	-69.7669983	3.0622799	-8	-2	0	0	152.4109955	121.3420029	114.2369995	121.4909973	124.3099976	0.0009825	0.0002258	0.0002308	0.0001614
351937.16	6614233.21	0	-47.3247986	2.94508	-1	-2	0	0	112.9290009	99.7246017	70.8024979	75.1798019	100.802002	0.0002741	6.87E-05	4.74E-05	2.75E-05
350809.43	6604695.01	0	-88.7613983	0.835228	-8	-4	0	0	71.1195984	37.9473	51	53.6655998	56.6039009	0.0005567	0.0004802	0.0004668	0.0001166
353902.16	6614362.29	0	-66.5995026	3.63729	0	0	0	0	150	154.0549927	129.1390076	132	138	1.90E-05	3.92E-05	3.25E-05	1.31E-05
352164.06	6600835.47	0	-69.5936966	3.3476	-9	-1	0	0	195.2079926	183.1719971	126	141.7960052	160.0160065	0.0006421	0.0006701	0.0003049	4.80E-05
352166.43	6600836.23	0	-69.5560989	3.20767	-9	-1	0	0	195.1609955	182.2359924	129	144.4989929	161.1369934	0.000677	0.0004578	0.0001101	9.76E-05
353935.22	6614362.31	0	-68.6986008	3.9798801	0	0	0	0	151.076004	156	129.3139954	132.1360016	141.8910065	1.23E-05	6.40E-06	3.90E-06	2.20E-06
350366.97	6601606.87	0	-74.2220993	2.02581	-1	0	0	0	203.9340057	224.0180054	99.7246017	103.9660034	106.0660019	0.0002162	0.0001293	0.0001193	4.61E-05
350830.67	6604708.26	0	-88.6894989	3.77723	-6	-2	0	0	95.2942963	61.8465996	75.1798019	77.8266983	80.7774963	0.0007161	0.000841	0.0002894	0.0001545
350598.90	6601347.49	0	-71.5827026	1.53764	-1	-1	0	0	112.9290009	92.4175034	96.0468979	98.9544983	101.8679962	0.0002893	0.0001663	0.0001329	7.98E-05
341643.60	6613768.01	0	-51.6207008	9.7155304	-2	0	0	0	132.3059998	282.3349915	48.4664993	48.4664993	51.2639999	0.0012096	0.0008268	0.0007267	0.0005106
355520.47	6612773.64	0	-88.3695984	13.0629997	-4	0	0	0	178.3170013	160.1000061	100.8460007	109.0780029	165.3269958	0.0015374	0.0005516	0.0002084	0.0001237
355380.74	6612783.62	0	-95.8498993	3.0964799	-6	-3	0	0	316.4249878	298.2250061	159.1130066	161.276001	165.4629974	0.0004458	4.24E-05	1.94E-05	4.40E-06
353713.60	6614357.97	0	-56.4339981	3.14503	0	0	0	0	229.6519928	208.0189972	204.0220032	206.8480072	212.322998	1.78E-05	8.70E-06	7.40E-06	3.00E-06
353401.47	6613076.59	0	-44.8690987	11.6190996	-1	0	0	0	83.1925964	61.8465996	37.589901	40.2491989	44.5982018	0.0018171	0.0004351	0.0002623	8.94E-05
354687.90	6608557.25	0	-98.944397	0.965837	-5	0	0	0	177	165	82.5409012	88.5888977	171.026001	2.37E-05	2.80E-05	1.82E-05	5.20E-06
354744.05	6608571.32	0	-99.3930969	0.627201	-2	0	0	0	234.1730042	219.3289948	141.3820038	146.5399933	228.1779938	1.22E-05	5.40E-06	3.20E-06	1.00E-06
349633.75	6602930.05	0	-74.2615967	1.07744	-2	0	0	0	62.4259987	37.589901	45	48.3735008	51.6139984	0.000354	0.0006738	0.0007951	0.0006682
354425.03	6614332.36	0	-93.7736969	3.4052501	0	0	0	0	191.1069946	352.8410034	87.6184998	92.4175034	198.2039948	0.0002946	6.00E-05	1.62E-05	2.26E-05
350827.11	6608364.51	0	-74.5180969	1.05565	-2	0	0	0	102.0439987	107.2050018	85.3815002	87.4643021	98.6812973	6.41E-05	2.01E-05	6.60E-06	3.00E-06
342864.27	6612078.00	0	-60.2820015	3.00295	-13	-2	0	0	72.4982986	102	42.4263992	44.5982018	46.6689987	9.26E-05	3.63E-05	2.02E-05	4.90E-06
355948.06	6612773.46	1	-69.3830032	24.1079006	13	7	9	6	0	0	0	0	0	0.0494009	0.0344351	0.0212606	0.0080887
351254.33	6599567.77	1	-62.4695015	19.8397999	3	5	-2	-1	21.2131996	3	0	0	3	0.0195009	0.0125536	0.00864	0.0049452
351212.39	6599539.95	1	-51.0824013	33.5238991	13	15	6	3	0	0	0	0	3	0.0483651	0.0147141	0.0078398	0.0040779
351218.53	6599542.81	1	-50.3749008	40.6165009	13	16	6	3	0	0	0	0	3	0.0435396	0.0246288	0.0177708	0.0038726
351298.02	6599596.40	1	-70.0651016	15.4862003	0	-4	-1	1	41.7851982	15	8.48528	8.48528	30	0.0076776	0.0027021	0.0019278	0.0011958
350938.99	6599412.05	1	-46.7975006	17.0422001	16	4	0	1	31.8903999	13.4164	15	3	3	0.0118094	0.0039598	0.0042324	0.0033553
351215.92	6599541.49	1	-50.2644005	35.9124985	14	16	6	3	0	0	0	0	3	0.0465199	0.020668	0.0103987	0.0048127
350856.10	6599385.85	1	-57.764801	15.2082005	3	2	1	0	45	66.4077988	0	3	4.24264	0.0049417	0.0060068	0.0045313	0.0018806
351027.18	6599485.67	1	-51.3512993	16.3145008	10	5	0	0	12.3692999	15.2971001	0	0	3	0.0149356	0.0094672	0.0065014	0.001344
350846.29	6599385.24	1	-59.5119019	13.8785	1	1	1	0	45.891201	75	3	3	4.24264	0.005368	0.0048272	0.0042577	0.0023313
350868.77	6599387.11	1	-55.8366013	7.1746802	4	2	1	1	39	56.3648987	3	0	6	0.0049794	0.0048625	0.0051019	0.0019333
350893.90	6599401.93	1	-53.5315018	7.91152	7	2	0	0	16.9706001	44.5982018	3	4.24264	6.7082	0.0100622	0.0048334	0.0015677	0.0008473
350815.63	6599366.38	1	-63.9855995	17.0063	-2	0	0	1	47.4342003	94.8683014	3	12	15	0.0066332	0.0048598	0.0030281	0.0014924
351261.31	6598408.24	1	-44.3502007	14.8652	21	2	-1	1	4.24264	0	0	0	0	0.114979	0.0946005	0.0762978	0.0525458
351400.50	6598356.52	1	-50.635601	24.7803993	16	7	5	2	3	0	0	0	0	0.0605862	0.0166338	0.0126988	0.0056775
350354.06	6603360.47	1	-71.5635986	7.99505	8	-4	-3	0	56.3648987	33	20.1245995	32.3110008	39	0.0068428	0.0014747	0.0011719	0.0005323
352028.12	6604342.48	1	-69.964798	20.7929001	-6	-8	-2	0	21.2131996	0	6	9	12	0.0213897	0.0017952	0.0013666	0.0006512
352083.23	6604397.26	1	-48.6245995	18.5487995	13	20	9	4	0	0	0	0	0	0.0347462	0.0302663	0.0163658	0.0057743
352010.31	6604347.46	1	-68.6981964	19.3488007	-4	-8	-3	0	17.4929008	0	0	3	9.4868298	0.0278332	0.0085424	0.0048382	0.0026109
352149.88	6604521.64	1	-65.8588028	21.9568005	-2	0	-2	-2	13.4164	0	0	0	0	0.0393074	0.0186864	0.0146948	0.007208
352576.88	6611424.64	1	-52.7350006	26.9477997	3	-2	2	2	3	64.8999023	0	0	0	0.0108158	0.0289756	0.0227756	0.0086939
353564.23	6611482.64	1	-65.7846985	31.8773003	3	0	0	0	6.7082	0	0	0	3	0.0416493	0.0151426	0.0095286	0.0023171
349866.99	6611490.96	1	-52.9477997	25.8451996	14	7	2	3	0	0	0	0	4.24264	0.027395	0.0171103	0.0069499	0.0010873
351381.80	6601465.06	1	-47.0657997	11.5086002	15	10	-1	-2	15	0	0	0	0	0.0471355	0.0319566	0.0176755	0.0068473
347929.71	6595211.14	1	-70.5039978	5.2172499	0	0	-4	-1	25.632	0	3	6.7082	8.48528	0.0493028	0.0031276	0.000881	0.0003799
348056.26	6595213.87	1	-65.328598	2.22896	0	-3	0	0	64.7611008	46.9574013	39	46.5724983	50.2891998	0.0026593	0.0031451	0.0025825	0.0012085
348080.41	6595210.57	1	-64.0363007	4.6303601	0	-2	0	0	87.8237	60.3737984	16.9706001	65.7950974	68.5419998	0.003163	0.0018913	0.0008286	0.0001408
348081.88	6595210.55	1	-64.0363007	4.6303601	0	-2	0	0	87.8237	60.3737984	16.9706001	65.7950974	68.5419998	0.003163	0.0018913	0.0008286	0.0001408
348149.98	6595211.74	1	-62.1208992	4.4812002	-3	0	1	0	87.8237	58.2495003	33	33	71.3091965	0.0029914	0.0036174	0.0029439	0.0010731
350262.49	6602985.36	1	-41.2854996	19.2730007	13	10	3	1	6	0	0	0	4.24264	0.0211731	0.0090868	0.0058628	0.0031931
350021.64	6603292.99	1	-51.8408012	6.5310702	9	0	-2	-1	15	0	0	3	4.24264	0.0461389	0.015335	0.0048845	0.0013196

349573.42	6614092.28	1	-43.9805984	10.7641001	29	8	-2	-2	16.9706001	0	0	0	3	0.0337098	0.0197911	0.0100861	0.0029589
355792.72	6609938.52	1	-66.1872025	18.2383995	-6	-7	-5	-2	21.6333008	0	0	0	0	0.0260114	0.0107038	0.0089888	0.0050938
354967.21	6607400.91	1	-65.1634979	35.0905991	8	5	5	5	0	0	0	0	0	0.0855916	0.0601711	0.0387505	0.013152
354992.37	6607482.52	1	-66.4433975	5.2332501	6	0	0	-1	9.4868298	0	0	0	0	0.0536592	0.031032	0.0219516	0.0080366
351906.46	6607203.18	1	-58.1380997	40.3535995	12	14	7	3	0	0	0	0	4.24264	0.0763509	0.0156668	0.0072534	0.0017323
350901.41	6608438.34	1	-70.7012024	9.7949104	-1	0	0	0	19.2094002	16.1555004	6.7082	8.48528	13.4164	0.0123956	0.0022684	0.0016404	0.0013169
348754.48	6594793.71	1	-82.0781021	4.84024	-2	-6	-2	0	27.6585999	3	6	9	12	0.0187779	0.0007119	0.0004381	0.000194
348663.36	6594842.77	1	-40.1402016	47.9328995	38	30	10	3	0	0	0	0	0	0.0339036	0.0379821	0.0410109	0.0308605
352115.04	6604113.88	1	-76.1732025	20.2747002	-8	-3	1	0	6.7082	0	0	0	0	0.036662	0.0255658	0.0166957	0.0078643
351557.38	6604982.35	1	-66.0145035	20.6208	0	-9	-9	-2	42.9534988	0	0	0	0	0.0409909	0.0165899	0.0122845	0.0054398
353917.75	6616537.56	1	-58.3723984	14.7188997	10	1	-1	-1	15	0	0	0	0	0.0254387	0.0175362	0.0120947	0.005089
353710.68	6616533.69	1	-51.3241005	6.68717	0	-10	-4	0	21.2131996	0	0	3	6.7082	0.0404681	0.0080596	0.0028593	0.0008391
351363.06	6605683.40	1	-49.5354004	40.2162018	17	9	9	2	3	0	0	0	3	0.0678744	0.0196865	0.0116725	0.0049427
351359.94	6605680.86	1	-47.1629982	33.6217003	20	11	11	3	0	0	0	0	3	0.0813375	0.0185788	0.0070134	0.0029919
344103.84	6610354.29	1	-66.3350983	24.4067001	9	11	9	2	3	0	0	0	4.24264	0.0378608	0.0123925	0.0059302	0.0011417
344103.34	6610354.76	1	-66.3350983	24.4067001	9	11	9	2	3	0	0	0	4.24264	0.0378608	0.0123925	0.0059302	0.0011417
343784.84	6611001.89	1	-45.7733002	16.1966	6	-4	-1	0	52.3927002	61.8465996	20.1245995	22.8472996	28.4605007	0.007037	0.002906	0.0028278	0.0015876
342913.52	6612098.07	1	-57.4389992	17.3871002	-9	-6	0	0	17.4929008	47.4342003	0	0	10.8167	0.0096024	0.0072387	0.0054361	0.0026448
342696.63	6611162.86	1	-70.5700989	4.5036702	0	-2	-2	-1	48.4664993	46.6689987	0	6.7082	48.3735008	0.0062947	0.0055261	0.0042409	0.002106

Table A.2. Terrain metrics and yelloweye rockfish presence in the Nuka Island area. Coordinates are in UTM 5N.

easting	northing	present	depth (m)	slope (deg)	bpi240	bpi120	bpi60	bpi30	dtb30 (m)	dtr21 (m)	dtr7 (m)	dtr5 (m)	dtr3 (m)	vrm21	vrm7	vrm5	vrm3
635205.18	6576240	0	-71.436	3.5283	-3	-2	0	0	82.377197	54.083302	63.639599	67.416603	70.035698	0.0001392	0.0001609	8.00E-05	2.16E-05
631665.41	6568875.8	0	-80.623	1.63761	-2	-2	0	0	34.205299	27.6586	18.9737	21.8403	25.632	0.0028845	0.000509	0.0004178	0.0003616
629313.69	6570002.1	0	-57.194	2.2544401	0	-1	-1	0	43.680698	25.632	17.492901	19.2094	20.1246	0.005057	0.001505	0.0010477	0.0006182
630773.15	6573861.6	0	-42.591	1.65538	0	0	0	0	69.584503	63	54	57	57.314899	0.000123	0.0001858	0.0001919	0.0001258
629101.4	6564827.4	0	-80.208	9.2941904	6	2	0	0	93.434502	140.87199	33.941101	36.619701	41.6773	0.0028216	0.0009091	0.0007564	0.0004112
633514.79	6567220.7	0	-115.394	7.0751801	-6	0	1	0	69.065201	111	6	6	3	0.0027092	0.0028408	0.002876	0.0037828
635578.14	6577438.5	0	-76.154	3.7611499	-3	-2	-2	-1	45	60	0	0	3	0.0098391	0.0123426	0.0095847	0.0029864
629388.82	6566817.9	0	-74.484	2.2665	2	0	0	0	96	118.87	21.2132	24	28.460501	0.003111	0.0006559	0.0005831	0.0002939
632767.21	6566532.1	0	-113.094	8.72892	1	2	2	0	21.2132	125.929	18.9737	24.1868	30	0.0064357	0.0017701	0.0009909	0.0003264
628926.47	6571633.8	0	-49.994	2.52811	4	0	-1	0	30	17.492901	3	3	6	0.0089889	0.0047153	0.0024603	0.0004447
628348.98	6566670.6	0	-72.64	16.861099	-1	-1	-1	0	51.0882	42.953499	0	3	6.7082	0.0102747	0.0063963	0.0024537	0.0006781
635882.02	6573786.5	0	-74.735	2.89376	3	3	-1	0	38.1838	22.8473	19.2094	21.2132	25.455799	0.0066998	0.0013052	0.0008528	0.0006424
632387.81	6571296.9	0	-69.022	1.05812	-6	-3	0	0	60.373798	25.632	26.8328	25.632	27.6586	0.001412	5.67E-05	3.11E-05	3.39E-05
635263.86	6576237.1	0	-74.699	2.5884099	-4	-2	0	0	99.724602	73.054802	81.608803	84.480797	87.361298	0.0002193	0.0001274	8.92E-05	2.84E-05
633374.58	6569332.8	0	-87.573	2.7202499	1	-1	-1	0	74.276497	87.361298	12.3693	15	18	0.0047808	0.0002756	0.0002326	0.0001191
633466.21	6575020	0	-55.139	10.0267	-2	0	0	1	24.7386	17.492901	10.8167	12.7279	15	0.0137102	0.0018983	0.0011591	0.0006006
632622.87	6566614.6	0	-108.755	7.39393	4	2	0	1	36.619701	173.17	0	0	3	0.0085885	0.0057383	0.0057471	0.0045037
634654.21	6578824.7	0	-45.723	2.7732999	3	0	0	0	125.032	100.578	99.045403	101.514	69.778198	0.0013206	0.0010971	0.0010572	0.0005459
632288.96	6573623.5	0	-59.22	2.31703	-3	-2	-2	0	40.804401	13.4164	21.633301	24.7386	28.460501	0.0049983	0.0004743	0.0003807	0.000335
628862.79	6564798.1	0	-102.291	12.9613	1	0	-1	0	40.249199	20.1246	12.3693	18.248301	25.632	0.0084675	0.0015546	0.0013797	0.0008767
635273.17	6576238.8	0	-74.988	2.35777	-4	-2	0	0	94.725899	67.683098	75.179802	77.826698	80.498398	0.0002491	0.0001481	0.0001055	3.86E-05
628396.61	6566736	0	-75.071	0.740625	-3	-1	0	0	34.205299	122.119	19.2094	21.2132	25.806999	0.0022287	0.0001348	9.63E-05	5.05E-05
632286.12	6566595.9	0	-104.32	2.7969601	6	5	0	0	42.106998	29.6985	17.492901	19.2094	25.806999	0.0047899	0.0011793	0.000716	0.0004436
631611.93	6567641.1	0	-80.931	0.589652	4	1	0	0	32.311001	90	12	12.3693	16.1555	0.0041976	0.0029122	0.0024447	0.0006759
632391.06	6571437.6	0	-58.94	1.7972	6	2	0	0	30.149599	12	10.8167	16.1555	20.1246	0.0096761	0.0013516	0.000667	0.0003175
633404.15	6571173.1	0	-80.388	1.7154	-5	0	0	0	64.412697	57.939602	45.398201	51.3517	39.1152	0.0006513	0.0004053	0.0003092	0.0002003
632142.96	6566675.3	0	-107.734	2.4840801	-6	-1	0	1	60.299301	108.747	16.1555	12	12	0.002701	0.00216	0.0020888	0.0013303
632731.01	6566550.4	0	-110.498	3.0488701	4	4	0	0	31.3209	122.45	4.24264	16.1555	40.804401	0.0063951	0.0040037	0.0020576	0.0008676
633636.17	6570221.5	0	-88.223	2.8026099	0	-1	0	0	111.364	98.0867	96.840103	90.050003	90	0.0012537	0.0008835	0.0005838	0.0004885
636571.57	6580398.3	0	-64.272	1.46305	-1	-1	0	0	24	21	9	9	17.492901	0.0083145	0.0003046	0.0001734	0.0001756
631325.04	6567562.6	0	-79.706	1.87552	-2	-1	0	0	26.8328	62.425999	10.8167	13.4164	15	0.0083471	0.000523	0.0003912	0.0001738
630152.3	6572720	0	-52.817	1.49719	0	0	0	0	165.67999	148.43201	150.479	152.08501	154.871	0.0002335	0.0002162	0.000192	0.0001075
629254.42	6570320.3	0	-57.102	2.2195499	0	0	0	0	20.1246	18	3	6	8.48528	0.0080522	0.0016921	0.0003973	0.0005381
630242.91	6572742.2	0	-53.192	1.08158	0	0	0	0	120.337	200.192	105.683	108.665	111.647	0.0002931	0.0001048	6.16E-05	2.40E-05
633498.01	6567301	0	-113.077	7.8854198	0	-10	-2	0	51.613998	30.149599	6	6	0	0.0053673	0.0038714	0.0039711	0.0056102
631084.84	6563701	0	-108.32	2.55515	9	-2	0	0	64.202797	23.4307	33.941101	36.124802	41.6773	0.0016281	0.0009351	0.0008742	0.0008888
627049.7	6570371.8	0	-127.921	15.2319	-1	-2	-1	0	26.8328	35.114101	0	0	0	0.0118007	0.0055999	0.0053727	0.0053196
633307.52	6569759.5	0	-95.747	6.4656801	0	0	1	0	128.86	136.953	64.132698	55.317299	33.541	0.001795	0.0003665	0.0003212	0.0001401
630673.96	6569527.7	0	-66.65	2.3123701	1	2	0	0	40.360901	44.598202	28.460501	32.311001	33.136101	0.0021642	0.0009983	0.0008537	0.0004336
629918.35	6565027.9	0	-78.83	4.5547199	5	1	0	0	33.541	28.460501	18.248301	21.2132	27.6586	0.0060206	0.0015434	0.0008305	0.0008535
629104.84	6564828.5	0	-80.007	9.4047499	6	2	0	0	95.483002	142.239	31.3209	34.205299	39.1152	0.0028714	0.000966	0.0006032	0.000304
636562.33	6580436.3	0	-63.938	0.246683	-4	-4	0	0	30	18	18	21	24	0.0057561	9.21E-05	6.87E-05	5.17E-05
630899.81	6563538.7	0	-126.055	11.7844	-6	0	1	1	72.124901	87.8237	6	12	18	0.0046192	0.0046416	0.0026416	0.000304
636571.38	6580399.9	0	-64.059	1.87552	-1	-1	0	0	24.1868	21	9	9	16.1555	0.0083535	0.0003234	0.0001453	0.0001849
628064.66	6567347.4	0	-76.226	2.3856599	-3	-2	0	0	74.094498	67.416603	60.7454	63.285099	65.863503	0.0013221	0.0013629	0.0010766	0.0009504
628903.61	6571627.2	0	-50.572	5.2294698	3	1	0	0	12	0	3	6	12	0.0217153	0.0046334	0.0044566	0.002617
634328.36	6573219.1	0	-68.349	0.871421	0	0	-2	0	35.114101	4.24264	15	18	21	0.0144616	5.94E-05	1.72E-05	4.40E-06
636236.22	6578340.6	0	-75.971	9.1459703	0	2	1	1	70.228203	132.85001	4.24264	6.7082	13.4164	0.0039518	0.002995	0.0021255	0.0004448
635566.95	6577422.6	0	-75.3	4.7320499	-1	-3	-2	0	40.360901	38.418701	12	9.4868298	18.248301	0.015548	0.0012657	0.0018084	0.0024664
629332.73	6566728.3	0	-72.633	6.7831202	3	1	1	1	85.906899	204.74899	21.2132	21.633301	21.633301	0.0034834	0.001699	0.0011165	0.0002242
634337.33	6573373	0	-69.748	1.47277	0	-2	0	0	30	19.2094	10.8167	13.4164	17.492901	0.0081012	0.0005856	0.0005152	0.0003057
631548.04	6567814.3	0	-84.714	2.3209	0	0	0	0	110.309	141.50999	85.3815	88.232697	84.480797	0.00033	0.0003626	0.0003098	0.0001327
632325.06	6566577.2	0	-105.448	12.5713	6	5	0	0	21.2132	19.2094	8.48528	12.7279	17.492901	0.008625	0.0019857	0.0007555	0.0001948
630641.32	6569515.9	0	-67.667	2.1180201	0	2	1	0	60.7454	63.0714	34.205299	36.619701	53.413502	0.0012019	0.0003837	0.000287	0.0001342
632411.54	6567141.6	0	-103.207	1.67308	-7	-1	0	0	34.205299	245.065	21.2132	24.1868	27.166201	0.0009623	7.43E-05	3.34E-05	7.70E-06
630265.31	6572740.8	0	-53.833	1.14527	0	0	0	0	96.420998	213.084	81.884102	84.852799	87.8237	0.0004593	0.0002335	0.0001804	0.0001608
632367.8	6571308.9	0	-68.925	0.959879	-5	-3	0	0	57.7062	21.633301	21.633301	20.1246	20.1246	0.0021947	0.0001182	0.0001051	8.68E-05
632300.71	6571345.6	0	-67.531	3.64992	-3	-3	0	0	75.953903	58.940601	43.266602	44.294498	45.792999	0.0015758	0.0006551	0.0005018	0.0003613
633425.69	6569783.3	0	-88.575	7.8077102	7	8	2	1	26.8328	33.541	12	15	18	0.0060448	0.0013385	0.0008502	0.0003549
634280.39	6572375.1	0	-63.373	5.0549302	2	1	-2	0	26.8328	0	6	9	12	0.0287689	0.0005152	0.0001729	8.06E-05

631669.68	6571588.2	0	-62.031	0.674153	0	0	0	0	48.466499	32.311001	15	15.2971	34.205299	0.0015706	0.0014727	0.0010532	0.0003849
635114.74	6575359.3	0	-85.824	1.10781	-6	-5	-1	0	33.541	6	9.4868298	10.8167	13.4164	0.0118409	8.85E-05	9.05E-05	4.67E-05
629443.23	6570057.9	0	-57.627	3.3105199	1	-1	0	0	45	21	21.2132	21.2132	23.4307	0.0028503	0.0011139	0.0011496	0.0010669
635121.64	6575418.5	0	-85.501	1.99086	-7	-5	-1	0	79.202301	46.668999	58.2495	60.075001	64.622002	0.0026795	0.0004253	0.0003425	0.0001601
633510.71	6567172.9	0	-117.5	6.19136	-9	0	0	0	60.6712	159	3	4.24264	8.48528	0.0065655	0.004629	0.0035656	0.002974
630072.97	6565051.1	0	-73.592	6.1724801	15	4	2	1	44.598202	36.619701	31.8904	21	24.1868	0.0045128	0.0016179	0.0011128	0.0007011
633433.68	6569422.8	0	-89.934	0.584773	0	0	0	0	83.354698	148.946	51.613998	53.413502	56.364899	0.0010895	3.29E-05	1.88E-05	1.08E-05
633367.67	6571166.8	0	-79.983	1.21652	-5	0	0	0	82.975899	72.124901	57.314899	61.554901	55.8032	0.0006628	0.0006252	0.0005476	0.0001857
633436.37	6569786	0	-87.483	10.0375	8	9	3	1	21	25.632	9	12	12	0.0080557	0.0011316	0.0005213	0.00027
630644.83	6569517.6	0	-67.702	0.569889	0	2	1	0	57.939602	60.373798	32.450001	34.985699	51.0882	0.0012449	0.0004156	0.0003393	0.0001402
634683.65	6579062.8	0	-43.091	2.2785299	5	2	0	0	123.329	189.40401	112.929	114.826	18.9737	0.001278	0.0013199	0.0012943	0.0006516
633825.37	6574223.5	0	-63.788	12.6635	-1	-2	-1	0	36.496601	21	9	13.4164	17.492901	0.0090004	0.0023992	0.0009747	0.0005406
629470.08	6566913.4	0	-74.6	4.2455201	2	3	1	0	47.4342	87.361298	29.6985	33.941101	17.492901	0.0026042	0.0011047	0.0008281	0.0004199
629469.22	6570363.9	0	-56.74	0.528257	0	0	0	0	64.899902	68.4105	36.124802	36.619701	40.360901	0.0009202	0.0001754	0.0001547	0.0001687
636225.54	6578288.8	0	-77.79	0.598342	-2	-2	0	0	59.548302	84.480797	40.804401	42.953499	46.957401	0.0013266	0.0003782	0.0003163	0.0003704
630083.8	6572710.6	0	-52.531	1.39473	0	0	0	0	150	135.532	129	132	135	9.51E-05	9.41E-05	8.92E-05	7.03E-05
636724.96	6581613.5	0	-69.247	0.328918	-4	-5	-2	0	45.891201	35.114101	9.4868298	12.7279	15	0.0093924	0.0004646	0.0002776	0.0003273
630199.53	6567476.3	0	-76.15	0.953207	-1	0	0	0	146.53999	199.40401	107.415	65.795097	57.314899	0.0003876	0.0001074	0.000109	6.84E-05
630371.81	6565726.6	0	-94.684	0.773201	-1	-2	0	0	89.899902	132.034	32.450001	13.4164	15	0.0014345	0.001531	0.0016885	0.0015828
630370.04	6565709.7	0	-93.697	3.1294899	0	-2	0	0	94.868301	126.178	46.957401	26.8328	27.6586	0.0016311	0.0004107	0.0003812	0.0002048
633836.58	6574126.6	0	-66.787	0.493857	-2	-1	-4	-2	22.8473	0	6	9	12	0.070947	0.0014554	0.0004866	0.0001187
630679.28	6569528.6	0	-66.727	0.923791	1	2	0	0	36.124802	40.804401	22.8473	26.8328	27.166201	0.0030223	0.0011988	0.0010763	0.0012309
629269.98	6570320.3	0	-57.254	0.986522	0	0	-2	0	29.6985	18	12.7279	15	18	0.0075925	0.001146	0.0008253	0.0005045
631580.99	6571636.5	0	-62.284	3.70028	0	0	0	0	48	27	27	30	33	0.0013312	0.001309	0.0015807	0.0012353
634079.33	6577302.4	0	-45.535	0.872281	0	-2	0	0	81.884102	48	54	57.078899	60.075001	0.0001066	0.0003117	0.0001711	0.0001632
633284.1	6569373.3	0	-88.512	1.32038	1	-1	0	0	53.075401	133.795	33.941101	17.492901	20.1246	0.001572	0.0010498	0.0005417	0.0003045
630847.04	6564715.6	0	-83.358	4.9632802	6	4	1	0	13.4164	78.057701	0	0	3	0.0072769	0.008047	0.0056502	0.0014219
630219.13	6572736.5	0	-53.07	1.42294	0	0	0	0	144.77901	183.81	130.25	133.222	136.19501	0.0002282	0.0001495	0.0001317	5.56E-05
631495.97	6567492.9	0	-81.28	7.5353999	0	2	1	0	102.176	113.565	15	16.9706	21.2132	0.0040111	0.0030009	0.0032777	0.001524
630020.48	6572705.2	0	-52.393	1.39116	0	0	0	0	145.98599	148.946	125.284	124.31	100.578	0.0001278	6.97E-05	4.46E-05	1.96E-05
632181.78	6566654.4	0	-109.068	2.3584199	-4	-1	0	0	63.639599	120.785	27.6586	16.9706	15	0.0020567	0.0030307	0.0032417	0.0037485
632666.17	6575584.9	0	-42.444	1.29248	0	0	0	0	68.542	72.124901	55.154301	57.939602	58.2495	0.0001523	4.12E-05	4.29E-05	3.95E-05
631582.41	6564050.8	0	-95.217	4.43466	19	0	-2	0	30.149599	0	9	12.3693	15	0.0204409	0.0028565	0.0019897	0.0005139
633894.24	6568205.6	0	-110.989	4.0837302	-3	-2	0	0	85.959297	237.60699	33.136101	33	30.8869	0.0016705	0.0008225	0.0006084	0.0004279
628881.42	6569043.9	0	-64.77	1.41013	-1	-5	-1	0	57.078899	34.205299	16.9706	19.2094	23.4307	0.0035546	0.0010575	0.0009479	0.0002331
629173.44	6572426.1	0	-52.625	1.62595	0	0	0	0	33.136101	56.364899	21	24	24.7386	0.0015902	0.0002592	0.0001774	7.75E-05
628184.89	6568397.3	0	-74.992	4.0594101	5	1	0	0	98.681297	133.795	82.975899	54.7449	55.317299	0.0010338	0.0011432	0.0014473	0.0014491
626449.59	6571226.4	0	-95.49	14.542	12	10	4	1	8.48528	10.8167	0	0	4.24264	0.0078738	0.00618	0.0054401	0.0021284
630679.73	6563663.9	0	-86.256	3.45802	24	8	5	1	17.492901	6	9.4868298	12.7279	16.1555	0.0177823	0.0025393	0.0023966	0.0021144
633510	6571199.2	0	-81.747	0.306933	-5	-3	0	0	63.780899	59.396999	45.694599	48.836498	53.075401	0.0004774	5.77E-05	2.83E-05	2.35E-05
628894.28	6569804.7	0	-54.589	1.68006	0	0	-1	0	27.6586	18	10.8167	13.4164	15	0.0122845	0.0007009	0.0001915	8.00E-05
631578.62	6567863	0	-86.453	3.7516999	0	0	0	0	54.083302	198.63499	39.1152	43.266602	53.075401	0.0007486	0.0004666	0.0003419	0.0001757
628928.12	6571633.8	0	-49.994	2.52811	4	0	-1	0	30	17.492901	3	3	6	0.0089889	0.0047153	0.0024603	0.0004447
629134.19	6567772.5	0	-74.203	3.05862	0	1	1	1	192.023	159	24.1868	17.492901	15	0.003565	0.0031533	0.0024932	0.0012527
632343.86	6571322.9	0	-68.694	1.31501	-4	-4	0	0	56.603901	24.1868	16.9706	19.2094	23.4307	0.0034327	0.0006277	0.0004746	0.0005583
631129.76	6563689.5	0	-108.476	0.945373	11	0	0	0	88.842598	65.795097	19.2094	23.4307	42.426399	0.0027549	0.000753	0.0004476	0.0004479
633286.44	6569762.9	0	-96.135	6.08707	-1	0	0	0	146.479	154.43401	44.598202	36.2491	12.3693	0.0018935	0.0018305	0.001839	0.000935
632414.11	6567204.4	0	-103.123	1.81326	-7	-1	0	0	96.187302	297.96799	70.611603	56.364899	55.072701	0.0003136	7.98E-05	5.43E-05	5.68E-05
626694.26	6571296	0	-91.932	9.6810999	0	0	0	0	129.035	159.452	57	57	44.598202	0.001073	0.0005814	0.0004362	0.0002458
630045.68	6572707.9	0	-52.376	0.745276	0	0	0	0	151.34399	140.45599	130.25	133.15401	127.35	9.04E-05	4.14E-05	1.89E-05	1.00E-05
636724.66	6581668.1	0	-68.97	1.50761	-5	-8	0	0	73.790199	43.680698	34.205299	37.108002	10.8167	0.0011686	0.0021125	0.0015708	0.0011146
628583.07	6565206.3	0	-92.446	3.2966001	8	4	3	1	78.057701	69	54.332298	56.044601	60.6712	0.0028979	0.0014845	0.0009717	0.0007069
635242.84	6576238.9	0	-73.69	3.1965499	-4	-2	0	0	104.657	76.3675	87.206596	89.899902	92.660698	0.0001864	0.0001675	8.51E-05	2.38E-05
629990.25	6565044.1	0	-76.523	2.65639	9	3	0	0	57.314899	47.4342	4.24264	6	9	0.0078758	0.0019232	0.0008951	0.0003894
633788.48	6568078.5	0	-101.161	7.4326701	6	5	2	1	56.364899	249.56	31.3209	31.3209	12.3693	0.0027191	0.0028675	0.0026273	0.0016872
633516.03	6567239.1	0	-114.698	2.8771901	-4	0	1	0	80.610199	93	24	24	18.248301	0.002529	0.0013125	0.0013318	0.001261
634277.14	6572410.5	1	-53.423	46.229199	12	10	6	0	3	6	0	0	0	0	0.0787237	0.0903339	0.0607774
631727.89	6569813.2	1	-49.032	5.94034	14	-2	-1	-1	9.4868298	0	0	0	0	0.0670852	0.0395088	0.0191369	0.0112031
632070.89	6572885.9	1	-26.45	41.115601	28	21	15	7	0	0	0	0	0	0.210069	0.100177	0.0527123	0.0206395
633453.39	6567416.9	1	-79.925	13.3315	28	17	2	0	20.1246	0	0	0	0	0.0633593	0.0173029	0.0191713	0.010825
628964.98	6569823.1	1	-44.393	32.690102	9	9	8	4	0	0	0	0	0	0.0571714	0.0737284	0.0575265	0.0211017
632504.54	6573044.8	1	-52.743	6.0924001	1	-1	-1	0	21.8403	0	4.24264	6.7082	9.4868298	0.0208597	0.0013629	0.0007865	0.0006959
627994.4	6567278.7	1	-68.388	23.674101	4	6	1	0	15	0	0	0	3	0.0332083	0.0083194	0.0060902	0.0039088

629445.8	6566898.1	1	-74.587	5.7454901	2	2	0	0	44.598202	71.561203	33.541	26.8328	27.6586	0.0027793	0.0013583	0.0012249	0.0007608
631372.95	6565923.1	1	-81.086	20.794399	25	10	5	2	6	0	0	0	3	0.0335404	0.0134012	0.0066747	0.0014555
634061.38	6570186.1	1	-82.458	18.7489	12	11	9	3	0	0	0	0	0	0.0479491	0.0164775	0.0106928	0.0071587
635453.9	6572615.4	1	-50.177	13.8434	22	15	8	4	0	9.4868298	0	0	0	0	0.095491	0.0833378	0.0664954
631736.47	6569778.5	1	-51.782	4.2290201	9	-2	-4	0	31.3209	6.7082	0	0	18.248301	0.0148294	0.0053809	0.0051221	0.0026595
634721.33	6576123.9	1	-27.452	36.117298	16	3	5	2	3	0	0	0	0	0.145715	0.169456	0.110903	0.0695512
630367.49	6565610.1	1	-86.133	8.5729904	7	1	-1	0	45.792999	32.450001	12.3693	18	18.248301	0.0060821	0.0014376	0.0016289	0.0012463
631379.05	6565928.4	1	-80.941	13.2921	25	10	5	3	0	0	0	0	3	0.0328791	0.0165138	0.0136076	0.0047396
633476.83	6567408.8	1	-74.213	39.853901	35	26	10	2	3	0	0	0	0	0.0643873	0.0222901	0.0193654	0.0171972
631498.57	6567493.8	1	-81.487	5.20434	0	2	0	0	99.181603	114	12.7279	15	19.2094	0.0041982	0.0028925	0.0029346	0.0025864
630676.37	6571038.2	1	-49.467	11.2598	9	2	-2	-4	6	0	0	0	0	0.113816	0.164484	0.167377	0.146565
630585.48	6571191.6	1	-53.451	3.33812	3	-1	-2	-1	16.1555	0	0	0	3	0.0526106	0.0236044	0.0134948	0.0034907
636504.49	6580613.7	1	-33.733	47.436699	28	16	6	-3	9.4868298	0	0	0	0	0.126674	0.0717794	0.0489919	0.012931
630897.78	6569711.2	1	-54.808	12.3552	9	7	5	2	3	0	0	3	6	0.0245705	0.0067488	0.0034425	0.0012876
632416.67	6567361.2	1	-92.912	3.6713901	2	1	1	1	51	234.787	39	42	40.804401	0.0019025	0.0019485	0.0021002	0.0026522
628298.5	6568523.6	1	-68.163	10.4005	10	5	1	0	12	48.0937	0	0	3	0.0114619	0.0110896	0.0067288	0.0020539
628931.49	6569836.4	1	-51.062	10.3079	2	1	0	0	18.248301	0	3	6	9	0.0217541	0.0047444	0.0024059	0.0003313
632169.59	6572911.3	1	-38.158	12.114101	16	12	4	-3	9.4868298	34.205299	6	3	0	0	0	0	0.0204894
629305.69	6572457.4	1	-40.82	34.585499	10	10	9	6	0	0	0	0	0	0.0489228	0.082227	0.0911219	0.0454805
634837.11	6576286.3	1	-26.372	19.699699	21	10	4	1	3	0	0	0	0	0.160331	0.0876353	0.0877046	0.0389502
634330.77	6573277	1	-62.776	23.710501	5	6	3	0	10.8167	0	0	0	0	0.0821211	0.0410225	0.0192965	0.0075654
630368.64	6565596.4	1	-85.289	5.52811	8	3	-3	-1	33.941101	21.2132	0	3	4.24264	0.0143649	0.007653	0.0043488	0.0014656
632883.83	6569650	1	-75.384	8.6696901	16	9	3	0	30.594101	21.8403	0	0	0	0.0111557	0.0080091	0.0078634	0.0057561
635102.05	6576221.9	1	-61.289	21.885	-3	-4	0	-1	18	0	3	6	10.8167	0.0213749	0.0038917	0.0020153	0.0011123
631736.29	6569779.7	1	-51.559	5.2280202	10	-2	-4	0	34.205299	8.48528	3	3	18	0.0142245	0.0048484	0.0028305	0.0006396
635455.99	6572613.8	1	-53.271	29.2992	19	12	5	1	3	13.4164	0	0	0	0	0.107168	0.116905	0.110621
629294.99	6572456.6	1	-44.202	13.079001	7	7	6	2	3	0	0	0	0	0.0572831	0.0296217	0.0231648	0.0111725
629379.15	6570037	1	-56.43	7.2308102	1	-1	0	0	40.025002	16.9706	6	17.492901	24	0.0070036	0.0022554	0.001534	0.0008903
636175.57	6581207.2	1	-51.446	12.6367	0	0	-3	-3	21.8403	0	0	0	0	0.0399599	0.0404703	0.049785	0.0327826
632015.39	6572850.5	1	-42.059	15.7794	13	5	1	1	3	0	0	0	0	0.0695288	0.0749412	0.0729632	0.0295818
631729.35	6569807.5	1	-49.317	3.4632499	13	-2	-1	-1	15	0	0	3	4.24264	0.0584168	0.0106901	0.0049469	0.0009105
630582.46	6571195.3	1	-54.391	7.2835102	2	-2	-2	-1	22.8473	0	3	6	3	0.0341629	0.004284	0.0035419	0.0041596
632016.21	6572851.2	1	-41.934	17.2812	13	5	1	1	4.24264	0	0	0	0	0.0685437	0.0730113	0.0622473	0.0283325
634094.98	6577377.7	1	-44.718	23.573401	0	-4	-6	-4	6	0	0	0	0	0.103574	0.115343	0.127925	0.121129
627968.79	6567233.1	1	-60.12	13.856	13	9	7	1	6.7082	0	0	0	0	0.0337994	0.0153425	0.0171738	0.0122383
635455.48	6572614.2	1	-51.88	36.667999	20	14	6	1	0	12	0	0	0	0	0.0926214	0.113586	0.0917354
634713.85	6577817.5	1	-55.35	15.9997	1	4	5	1	4.24264	0	0	3	6	0.0777451	0.0216634	0.0049539	0.0017077
629321.38	6570011.1	1	-57.727	0.677112	0	-2	-1	0	41.6773	25.455799	18	15	21.633301	0.0058178	0.0024354	0.0016703	0.0012967
633137.34	6573127.7	1	-59.73	10.8098	1	1	4	1	6.7082	0	0	0	0	0.0610175	0.0302369	0.0167167	0.0124512
628773.88	6569790.1	1	-51.778	24.879801	3	1	0	0	4.24264	0	0	0	0	0.0361275	0.0277261	0.0245783	0.0178987
633527.24	6567413.6	1	-78.582	34.388802	30	24	13	0	6	6	0	0	0	0	0.033972	0.0377814	0.0302195
626693.61	6569030.8	1	-52.985	6.7730699	11	-1	-3	-1	16.1555	0	0	0	4.24264	0.0354584	0.017755	0.0059028	0.0010933
629250.44	6572445.5	1	-50.772	11.6217	0	0	0	-1	12	0	0	0	0	0.0383992	0.0275648	0.0216994	0.0056236
631971.82	6572846	1	-43.194	21.3624	12	4	-1	-3	13.4164	0	0	0	0	0.0921058	0.0620387	0.0270885	0.011443
627998.89	6567280.5	1	-70.048	24.343901	2	4	0	0	15	0	0	3	4.24264	0.0286499	0.008283	0.0043468	0.0013711
629301.4	6572457.4	1	-42.35	33.387798	9	9	7	3	0	0	0	0	0	0.0511726	0.0769483	0.0663353	0.028295
630367.2	6565604.9	1	-85.85	3.0494299	7	2	-2	0	40.804401	27.6586	6.7082	12	12.3693	0.0090843	0.0020343	0.0016518	0.0010783
630097.67	6565071	1	-71.331	5.5682802	15	7	1	0	49.203701	25.806999	3	0	0	0.0082408	0.0047961	0.0054686	0.0055749
634716.62	6577849.6	1	-61.287	2.1284399	-5	0	0	-2	21.2132	0	0	3	9	0.0589361	0.0065307	0.0031888	0.0010793
633278.11	6569497.4	1	-89.833	7.3291202	3	3	1	1	69.065201	255.282	9	9	16.1555	0.0044707	0.0038012	0.0028589	0.0021503
626703.37	6569045.5	1	-47.513	4.8070402	15	4	0	2	9.4868298	0	0	0	0	0.0362839	0.0223249	0.0183696	0.012298
635410.22	6575641.4	1	-50.196	33.538399	33	28	18	9	0	0	0	0	0	0.141258	0.0657957	0.0633861	0.0391501
626610.55	6568924.4	1	-52.757	8.4797096	19	7	4	0	6	0	0	0	0	0.0653076	0.0434917	0.0431592	0.0316207
628936.53	6569109.3	1	-53.51	17.983999	8	4	0	0	8.48528	0	0	0	0	0.0605693	0.0582323	0.0727358	0.0525773
629308.8	6572457.3	1	-42.313	39.347599	9	9	7	4	0	0	0	0	0	0.0465123	0.077997	0.0800365	0.0450872
632469.92	6572959.3	1	-47.115	7.1322498	8	3	1	0	16.9706	3	0	3	6	0	0.0071993	0.0017013	0.0008418
635518.67	6577319.1	1	-65.531	29.1822	9	3	-2	-4	12	0	0	0	0	0.0968229	0.0456914	0.0256624	0.0106325
635516.1	6577316.4	1	-62.403	36.2533	12	7	0	-3	8.48528	0	0	0	0	0.104528	0.0440495	0.0266066	0.00585
636506.13	6580621.7	1	-28.213	45.7649	33	21	9	0	3	0	0	0	0	0.127316	0.036786	0.0336673	0.0153108
635323.42	6575530	1	-73.469	9.6141396	7	0	0	0	27.6586	21	3	18.9737	21.633301	0.0077437	0.0048401	0.0046279	0.0026215
629436.57	6566891.7	1	-74.948	0.631751	2	2	0	0	48.373501	68.014702	36.619701	30.149599	33	0.0028527	0.0018507	0.0012609	0.0007646
631736.52	6569778.1	1	-51.782	4.2290201	9	-2	-4	0	31.3209	6.7082	0	0	18.248301	0.0148294	0.0053809	0.0051221	0.0026595
634368.89	6575873.8	1	-46.423	18.3727	7	9	0	-2	9	30	9	6	3	0	0	0	0

630370.1	6565825	1	-93.652	1.11824	0	1	0	0	33	33.136101	18	21.2132	21	0.0045853	0.0005662	0.0004534	0.0001491
627910.19	6567183	1	-59.504	59.442902	16	10	0	0	4.24264	0	0	0	3	0.0945227	0.0423356	0.0155291	0.0030538
634858.69	6572189.1	1	-64.664	8.7249002	3	-2	-2	0	27.6586	17.492901	0	0	3	0.0130202	0.0088311	0.0067973	0.0037643
636526.13	6580542.6	1	-55.046	19.910999	8	-4	0	0	6	0	0	0	0	0.0346207	0.0106586	0.0082864	0.0067831
632068.57	6572885.6	1	-29.035	54.470001	26	19	13	5	0	0	0	0	0	0.205359	0.0856671	0.0403835	0.0125049
630369.43	6565593.9	1	-84.715	10.1843	9	3	-2	-1	29.6985	21.633301	0	0	4.24264	0.0140051	0.009789	0.0066485	0.0027457
629121.88	6567984.8	1	-58.199	9.2701902	16	14	11	2	3	0	0	0	0	0.0736977	0.0246302	0.0177853	0.0122741
634714.04	6576157.7	1	-29.706	26.8769	12	0	1	6	3	0	0	0	0	0.121326	0.170778	0.20672	0.24979
628951.33	6569133	1	-49.172	26.252001	12	8	1	1	3	0	0	0	0	0.0756466	0.0828863	0.0751581	0.0505342
634829.55	6576272.7	1	-31.903	36.784199	15	4	-3	-5	8.48528	0	0	0	0	0.156806	0.201807	0.223366	0.157089
630849.11	6564815.6	1	-85.791	17.663601	9	6	5	3	0	0	0	0	0	0.0204253	0.0174939	0.0159267	0.0100925
636008.69	6577595.3	1	-58.098	16.7787	24	19	8	-1	6.7082	0	0	0	0	0.0825978	0.0763068	0.0755804	0.0462673
630955.27	6569753.8	1	-58.545	19.8829	6	3	3	1	8.48528	0	0	0	0	0.0226067	0.008128	0.0084983	0.0072606
626634.4	6568947.7	1	-57.807	13.246	15	1	-4	-1	10.8167	0	0	0	0	0.0719863	0.0237964	0.020534	0.0113009
632459.28	6571450.6	1	-56.237	2.5734301	10	4	-2	-3	21	0	0	0	3	0.0537602	0.0309296	0.0159558	0.0041837
628769.04	6569788.7	1	-50.325	30.5569	4	2	0	0	4.24264	0	0	0	0	0.0401438	0.0361234	0.0277693	0.0102105
626708.21	6569052	1	-47.469	8.7110004	15	4	0	1	15	0	0	0	4.24264	0.0387729	0.0125196	0.0072702	0.0024779
633453.12	6575087.6	1	-42.452	13.875	10	12	4	-1	8.48528	0	0	0	0	0.071011	0.0409378	0.0356791	0.0235378
628846.45	6569794.6	1	-53.263	5.9501901	2	0	0	-1	21.2132	0	0	0	0	0.0314261	0.0142335	0.0144362	0.0173631
627917.21	6567184.9	1	-69.618	38.725102	6	0	-10	-5	10.8167	0	0	0	0	0.0957327	0.0701774	0.0591871	0.0455882
629122.79	6567983.2	1	-58.199	9.2701902	16	14	11	2	3	0	0	0	0	0.0736977	0.0246302	0.0177853	0.0122741
631583.93	6564109.9	1	-97.674	12.3143	16	3	-1	0	39.1152	8.48528	3	4.24264	4.24264	0.0174968	0.0046073	0.0032626	0.001352
631714.8	6563141.3	1	-132.359	11.8893	9	6	3	0	56.364899	168.42799	39	40.249199	36.124802	0.0046003	0.0008301	0.000392	0.0003005
631728.2	6569812	1	-49.032	5.94034	14	-2	-1	-1	9.4868298	0	0	0	0	0.0670852	0.0395088	0.0191369	0.0112031
628988.04	6569819.8	1	-46.781	37.376801	6	7	6	1	3	0	0	0	0	0.0704622	0.0885106	0.0831958	0.0291607
631435.83	6571687.5	1	-53.216	11.3555	8	8	8	4	0	0	0	0	0	0.0348712	0.043028	0.0243319	0.0097415
631582.54	6563957.1	1	-94.12	4.3852401	16	3	2	1	18.248301	41.785198	0	3	3	0.0119495	0.005737	0.0048861	0.002526
628932.74	6569105.7	1	-53.199	24.028	8	4	1	1	9.4868298	0	0	0	0	0.0600664	0.0680676	0.0551547	0.0717623
632123.15	6572899.4	1	-35.108	54.966099	19	15	3	-2	3	15	0	0	0	0	0.151699	0.105221	0.0661137
633525.48	6567413.3	1	-78.582	34.388802	30	24	13	1	6	6	0	0	0	0	0.033972	0.0377814	0.0302195
627924.7	6567191.2	1	-74.7	5.66504	0	-4	-14	-5	21.633301	0	0	0	0	0.0870825	0.0308805	0.0268015	0.0523474
628856.9	6569794	1	-53.584	8.7265501	1	0	0	0	25.806999	0	0	3	4.24264	0.0255644	0.0068756	0.0040079	0.0027259
630010.16	6565048.3	1	-74.283	5.7680702	12	5	1	1	39.1152	32.311001	3	0	3	0.0092629	0.0048905	0.0056757	0.0045398
631523.4	6567520.8	1	-79.391	10.3913	3	4	1	1	77.884499	88.842598	6	6	6.7082	0.0060009	0.0042394	0.0034627	0.0012206
630096.08	6565069.5	1	-71.378	6.7475801	15	7	1	0	51.0882	27.6586	6	3	3	0.0077631	0.0042814	0.0047502	0.0046714
628987.37	6571639.2	1	-42.002	17.6798	12	8	3	0	10.8167	0	0	0	0	0.065774	0.0464246	0.0471765	0.0419813
634800.05	6576250.7	1	-25.371	52.562698	21	11	0	-3	3	0	0	0	0	0.140088	0.236081	0.22915	0.142376
635528.93	6577344.7	1	-65.653	22.351299	9	3	-1	-1	12	0	0	0	3	0.0558139	0.0146192	0.0101319	0.0038306
631726.2	6569820	1	-48.68	5.0389299	15	-1	-1	-1	8.48528	0	0	0	0	0.078545	0.0637593	0.0585555	0.026741
630946.64	6569743.8	1	-58.175	30.289801	6	3	3	2	4.24264	0	0	0	0	0.0300486	0.022024	0.0213898	0.0158802
626733.99	6569093	1	-48.475	23.9905	15	2	-3	-1	6	0	0	0	0	0.100244	0.173459	0.20433	0.165077
630924.76	6569723.6	1	-53.61	1.22742	11	8	7	3	0	0	0	0	6.7082	0.0431449	0.0133766	0.0065597	0.0027726
628992.12	6569820.7	1	-48.26	12.3555	5	5	5	0	6	0	0	0	0	0.0710621	0.080964	0.0891474	0.0919622
630096.87	6565070.3	1	-71.331	5.5682802	15	7	1	0	49.203701	25.806999	3	0	0	0.0082408	0.0047961	0.0054686	0.0055749
635597.29	6572529	1	-69.577	8.8968697	0	0	-2	0	22.8473	0	0	0	15	0.0253961	0.0056313	0.0053757	0.0025679
628737.49	6565409.6	1	-86.039	8.3457403	0	2	1	0	27.6586	72.498299	0	3	6.7082	0.0092197	0.0068995	0.0016512	0.0009422
632142.35	6566675.7	0	-107.734	2.4840801	-6	-1	0	0	60.299301	108.747	16.1555	12	12	0.002701	0.00216	0.0020888	0.0013303
631677.19	6571425	0	-62.242	0.486724	0	0	0	0	49.477299	33	35.114101	40.249199	45.398201	0.00036	0.000103	0.0001087	3.03E-05
633817.78	6574250.4	0	-65.555	1.01098	-3	-6	-2	0	47.4342	15.2971	30	33.941101	36.124802	0.0028328	4.09E-05	3.21E-05	3.35E-05
632576.51	6566625.7	0	-113.077	11.3608	-1	-2	0	0	78.917702	156	0	0	0	0.0055694	0.0076705	0.0084344	0.0055888
627731.66	6564305.7	0	-135.15	7.25951	-3	0	1	0	40.249199	101.203	24	24.1868	27.166201	0.0029154	0.0011133	0.0011853	0.0008813
633501.47	6567116.7	0	-119.97	5.0517001	-8	0	0	0	60.373798	205.866	47.4342	31.8904	21.633301	0.0023603	0.0019616	0.0015607	0.0006986
632314.41	6571338.8	0	-68.299	1.86467	-4	-3	0	0	67.416603	46.572498	28.460501	29.5466	31.3209	0.0016855	0.0009152	0.0009483	0.0003053
627108.75	6570338.3	0	-140.981	3.3213201	-18	-7	-1	0	66.407799	90.050003	33	36	36	0.0027873	0.0011961	0.0007569	0.0004445
633469.96	6574960.8	0	-60.53	1.4683	-6	-2	0	0	68.4105	42.426399	29.5466	31.3209	34.205299	0.0006301	0.0003545	0.0002531	0.0002748
628954.23	6564798.6	0	-85.083	17.515499	13	6	1	1	21.2132	32.450001	0	0	6	0.0100124	0.0055496	0.0051487	0.0026538
631537.07	6567801.2	0	-83.939	1.81012	1	1	0	0	108.416	124.31	72.993103	75.953903	72.560303	0.0004135	0.0003585	0.000325	0.0002309
630185.31	6567614.2	0	-76.161	1.99915	0	0	0	0	86.533203	138.716	57.628101	57.314899	15.2971	0.0022045	0.0024416	0.002759	0.0024527
630883.29	6563569.7	0	-120.012	6.6903501	-2	0	0	0	74.518501	84.9058	38.418701	42.426399	36.496601	0.0012998	0.0003583	0.0004248	0.0002725
631079.7	6563700	0	-108.558	1.1477	8	-2	0	0	63.285099	21.633301	32.311001	34.985699	39	0.0017588	0.0012211	0.001143	0.0007346
628884.15	6569047.5	0	-64.634	1.0308599	-1	-5	-1	0	59.774601	28.460501	13.4164	15	19.2094	0.006843	0.000335	0.000278	0.0002633
632666.81	6575581.5	0	-42.389	1.4239	0	0	0	0	71.309197	74.276497	57.939602	60.7454	60.7454	0.0001598	0.0001066	6.60E-05	7.26E-05
636232.04	6578350	0	-77.012	3.7557001	0	1	0	0	77.826698	145.121	15	17.492901	18.248301	0.0034565	0.0013131	0.0007202	0.0002808

630184.54	6567612.9	0	-75.927	2.3853199	0	0	0	0	89.044899	139.84599	55.8032	55.317299	12.3693	0.0021693	0.0029452	0.0027479	0.0025524
633467.4	6575013	0	-57.112	12.515801	-5	-1	0	0	33.541	21.633301	4.24264	6.7082	9.4868298	0.0107416	0.0036357	0.0025343	0.0006601
633861.75	6573312	0	-65.614	3.2825899	-1	0	0	0	15.2971	0	0	3	4.24264	0.0236398	0.0085032	0.0048474	0.0015649
633482.15	6569406.8	0	-89.675	3.1200099	1	-1	0	0	64.622002	122.156	3	3	6	0.0045509	0.0048971	0.0027297	0.0013446
626683.83	6571450.2	0	-77.063	4.3702302	11	2	0	0	64.202797	72.124901	13.4164	17.492901	22.8473	0.0066043	0.0018226	0.0014123	0.0007786
632236.7	6571414.9	0	-62.571	0.793537	1	2	0	0	75.239601	124.455	63.285099	66.610802	56.921001	0.0009539	0.0006876	0.0003666	0.0001023
626691.95	6571325.6	0	-87.015	8.8551102	5	2	1	0	134.733	167.356	51.3517	48.373501	36	0.002064	0.0007558	0.0005589	0.0002962
632623.7	6566613.8	0	-108.194	5.6098199	5	2	1	1	38.418701	173.922	0	0	0	0.0082264	0.0059092	0.0080566	0.0075232
631544.84	6567810.4	0	-84.518	2.31759	0	0	0	0	115.918	134.83299	80.777496	83.678001	80.050003	0.0003452	0.0002981	0.0002459	0.0002081
632602.02	6566621.3	0	-109.819	7.18994	2	0	0	1	53.160099	183	9.4868298	10.8167	12.3693	0.0066016	0.0038825	0.0028005	0.0004613
629450.48	6566898.9	0	-74.357	8.2307701	2	3	1	0	45.694599	74.094498	34.205299	28.301901	27.166201	0.0026782	0.0011853	0.0012822	0.0013555
631664.59	6568926.3	0	-78.99	5.6508498	0	-1	0	0	84.213997	78.517502	47.4342	45.694599	46.957401	0.0015902	0.0005881	0.000437	0.0003677
632416.82	6567257.5	0	-101.485	1.8997999	-6	-2	0	0	102.703	296.98499	19.2094	21.2132	21.2132	0.0015161	0.0004372	0.0003542	0.0002105
633662.14	6570221	0	-87.664	2.96578	0	-1	0	0	88.232697	74.094498	71.309197	73.545898	75.953903	0.0017967	0.0009113	0.0004771	0.0001175
632411.44	6567138.7	0	-103.153	1.53519	-7	-1	0	0	31.3209	242.759	18.248301	21.2132	24.1868	0.0016151	9.21E-05	3.42E-05	7.00E-06
634359.69	6575814.6	0	-59.269	18.398399	0	1	0	0	24	6	9	12	9.4868298	0.0143274	0.0022463	0.0018179	0.0013558
631469.2	6567469.2	0	-83.129	3.6819999	0	0	0	0	117.614	90.448898	42.953499	42.953499	45.891201	0.0022062	0.0014358	0.0012524	0.0008408
632315.54	6571338.2	0	-68.299	1.86467	-4	-3	0	0	67.416603	46.572498	28.460501	29.5466	31.3209	0.0016855	0.0009152	0.0009483	0.0003053
634283.16	6572228.8	0	-65.052	5.7488899	4	1	0	0	40.360901	51.0882	10.8167	8.48528	8.48528	0.0047267	0.0021915	0.0014285	0.0008411
633221.74	6569424.8	0	-89.35	7.7434402	1	0	0	0	23.4307	207.34801	12.3693	0	15	0.0051568	0.0047736	0.0054282	0.0027602
633841.69	6573461.2	0	-64.468	3.5957999	0	0	-1	0	21.2132	8.48528	4.24264	9	24.1868	0.0136197	0.0040158	0.0027114	0.0011289
633574.86	6571210.9	0	-82.653	3.2458999	-6	-4	-2	0	30.149599	18	12	15	17.492901	0.0129025	0.0005155	0.0004863	0.0003736
630182.71	6567607.2	0	-76.3	7.0075998	0	0	0	0	93.193298	143.78101	51.613998	51.0882	9	0.0021864	0.0030297	0.0035586	0.003588
633494.42	6567046.7	0	-119.979	1.12656	-6	0	0	0	23.4307	157.436	12.7279	13.4164	17.492901	0.0029528	0.0009977	0.0009702	0.0008128
632614.16	6566621.5	0	-108.637	8.2051201	3	2	1	1	41.785198	180.62399	6.7082	4.24264	3	0.0080776	0.0040512	0.0038306	0.0031207
632186.36	6571412.3	0	-62.248	2.3889201	1	2	0	0	126.321	168	48.466499	49.658798	57.939602	0.0011193	0.0002396	0.0002344	0.0001418
633258.85	6569521.4	0	-89.966	2.3849199	4	4	0	0	99.045403	230.76601	21	24.1868	33	0.0026839	0.0018031	0.0015454	0.0005439
633797.4	6570222.4	0	-71.47	7.0148802	18	14	8	2	12.7279	0	9.4868298	12.3693	15	0.0278392	0.0038373	0.003126	0.0013785
636726.57	6581631	0	-69.184	0.951283	-4	-6	-1	0	55.072701	46.8615	24.1868	28.301901	32.311001	0.0041638	0.0009353	0.0010983	0.0006511
633885.9	6568197.7	0	-110.649	2.8947001	-2	-1	0	0	75.179802	236.144	40.360901	36.2491	36.2491	0.0015389	0.0015957	0.0013509	0.0004756
633610.43	6570221.1	0	-88.522	0.809138	-1	0	0	0	133.15401	120.487	96.187302	66.0681	66	0.0011299	0.0012856	0.0010013	0.0007747
632600.6	6566621.1	0	-109.559	5.3642201	2	1	1	1	56.044601	180	8.48528	9.4868298	12.7279	0.0062751	0.0039945	0.0023818	0.0003366
630366.84	6565625.2	0	-87.663	7.05439	4	0	0	0	59.093102	45.694599	25.632	33	33.136101	0.0024103	0.001281	0.0011163	0.0012248
629131.75	6567971.5	1	-59.033	26.2787	15	13	11	6	0	0	0	0	0	0.0662879	0.0387301	0.0215569	0.0072248
629122.79	6567983.2	1	-58.199	9.2701902	16	14	11	2	3	0	0	0	0	0.0736977	0.0246302	0.0177853	0.0122741
629117.96	6568022.5	1	-60.524	23.439199	14	13	6	0	8.48528	0	0	0	3	0.0551158	0.0255532	0.0162883	0.0032721
628699.57	6565354.5	1	-86.185	5.9677701	1	3	2	2	37.589901	28.301901	4.24264	10.8167	13.4164	0.0101314	0.0037615	0.0035349	0.0025015
629070.09	6564821	1	-81.841	5.1103601	7	0	0	0	69.778198	123.693	32.311001	34.205299	30.594101	0.003213	0.0012388	0.0011579	0.0011069
631224.99	6563619.1	1	-113.191	1.90811	12	8	1	0	32.311001	10.8167	3	3	6	0.0145808	0.0045497	0.0026192	0.0014837
631025.85	6563727.5	1	-97.849	25.9275	14	8	3	1	6.7082	0	0	3	6	0.0382051	0.0070058	0.0038333	0.0035725
631012.56	6563733.8	1	-92.621	17.412001	19	12	8	3	0	0	0	0	3	0.0418055	0.0149738	0.0094383	0.0024549
631579	6564023.2	1	-95.298	3.81988	18	-1	-3	0	36.619701	27	15	17.492901	21.2132	0.0127487	0.0018808	0.001685	0.0018148
630002.82	6565046.9	1	-75.754	10.7261	10	4	0	0	46.8615	39	0	3	6	0.0086229	0.0053293	0.0036188	0.0017459
631343.33	6565899	1	-81.92	8.3205996	25	10	2	0	10.8167	0	0	0	6	0.0336544	0.0096726	0.0063724	0.002267
629421.39	6566866.1	1	-74.692	4.0009899	2	1	0	0	55.8032	77.826698	15	13.4164	17.492901	0.0038271	0.0016314	0.0009438	0.000676
633557.82	6567408.7	1	-92.92	38.214298	15	12	2	2	3	6	0	0	0	0	0.018538	0.0218633	0.024651
633555.9	6567408.4	1	-92.92	38.214298	15	12	2	2	3	6	0	0	0	0	0.018538	0.0218633	0.024651
633530.34	6567413.5	1	-77.595	28.122	31	25	14	1	6	6	0	0	0	0	0.0343801	0.0335034	0.0253378
633479.9	6567407.6	1	-72.171	39.821701	37	28	12	3	0	0	0	0	0	0.071797	0.0291826	0.0243732	0.019772
626667.44	6568992.5	1	-48.134	23.1567	21	5	6	-1	6	0	0	0	0	0.0860806	0.0170934	0.0141717	0.0174366
626714.74	6569060.8	1	-46.707	5.1719198	16	5	0	1	18	0	0	0	3	0.0526507	0.0150508	0.0088623	0.0038588
626715.24	6569061.9	1	-46.707	5.1719198	16	5	0	1	18	0	0	0	3	0.0526507	0.0150508	0.0088623	0.0038588
632846.47	6569685.2	1	-83.738	13.9292	7	-1	0	0	77.129799	69.778198	9.4868298	10.8167	12.3693	0.0041531	0.0015348	0.0010471	0.0008217
631729.34	6569871.2	1	-50.202	1.26551	13	3	-3	-3	12.3693	0	0	3	6	0.087506	0.0283476	0.0028623	0.0012394
631723.99	6569827.7	1	-39.431	53.8979	24	8	7	1	0	0	0	0	0	0.0953184	0.119251	0.135367	0.100081
631724.87	6569824.5	1	-45.282	57.032902	18	2	1	0	3	0	0	0	0	0.0890723	0.110622	0.102184	0.0379587
631741.58	6569731	1	-48.579	19.5177	7	4	1	0	6.7082	0	0	0	3	0.0409468	0.0158701	0.0124888	0.004764
631667.49	6569162.8	1	-78.856	30.833	-1	3	3	0	8.48528	0	0	0	3	0.0324351	0.0158139	0.0073412	0.0017837
628953.05	6571639.1	1	-48.604	4.07371	6	1	-1	0	15.2971	0	0	3	6	0.0238049	0.0083377	0.0042646	0.0013055
632431.87	6571446.7	1	-53.733	7.4251199	12	8	1	2	4.24264	0	0	0	0	0.0335325	0.0389844	0.0286709	0.0151159
632456.66	6571450.2	1	-56.367	2.3607099	10	4	-2	-2	21	0	0	0	3	0.0540626	0.0145262	0.0053357	0.0030572
631710.35	6572287.9	1	-46.018	19.480101	14	14	7	5	0	0	0	0	0	0.0567069	0.0573791	0.0444844	0.014591
634714.13	6577828.6	1	-55.881	22.626499	0	4	5	1	6	0	0	0	3	0.0764003	0.0330124	0.0108185	0.0043565

635513.85	6577314.1	1	-59.456	48.138199	15	10	3	-2	4.24264	0	0	0	0	0.121434	0.0301936	0.0195699	0.0131705
635527.26	6577334.4	1	-67.549	5.54421	7	1	-4	-3	18.9737	0	0	0	3	0.0793757	0.0142519	0.0087065	0.0021119
635594.5	6577460.6	1	-70.109	4.98803	2	5	3	1	19.2094	85.802101	6	9	12.3693	0.0151145	0.0027041	0.0010755	0.0003864
634873.74	6576363.7	1	-40.309	28.9361	12	2	4	1	3	0	0	0	0	0.124038	0.11992	0.0601372	0.0134109
635073.91	6576209.7	1	-51.151	10.1531	6	3	4	1	12.7279	12	0	0	6	0	0.0115265	0.0052638	0.0029738
635378.61	6575617.5	1	-74.182	19.5877	8	0	-5	-3	13.4164	0	0	0	0	0.0676643	0.0269931	0.0234936	0.0155721
633458.26	6575102.8	1	-36.912	28.077801	15	17	9	3	0	0	0	0	0	0.0875525	0.0511332	0.0334159	0.010914
635650.51	6571590	1	-82.12	10.7042	18	15	4	0	12.3693	0	0	0	0	0.0226551	0.0143344	0.0137124	0.0075443
634865.07	6572087.7	1	-49.97	17.258499	25	14	5	4	0	0	0	0	0	0.053775	0.0846021	0.076279	0.0492499
634878.92	6572149.9	1	-54.916	8.5229597	15	8	4	2	8.48528	0	0	0	3	0.0250575	0.0107932	0.0069896	0.002465
634275.13	6572435.6	1	-51.159	31.393101	14	13	9	0	3	21	0	0	0	0	0.0819229	0.0723823	0.0507803
636505.28	6580627.3	1	-24.192	38.368198	37	26	12	3	0	0	0	0	0	0.131005	0.0474368	0.045993	0.025541
636498.3	6580641.2	1	-17.161	18.355801	44	34	18	5	0	0	0	0	0	0.122354	0.0384623	0.0344409	0.0234789
632516.1	6573044.9	1	-52.895	3.3408699	1	-2	-1	0	21.8403	4.24264	8.48528	10.8167	13.4164	0.0162097	0.0011853	0.0012464	0.0007374
632590.87	6573175.9	1	-46.936	25.2794	8	9	3	2	3	0	0	0	0	0.0382845	0.037226	0.0205271	0.0108466
631956.75	6572846.3	1	-37.136	44.069401	18	11	3	4	3	0	0	0	0	0.111268	0.110371	0.0793285	0.0357547
632021.04	6572856	1	-40.243	17.4195	15	7	2	3	0	0	0	0	0	0.0702612	0.0707946	0.0662672	0.0430057
632098.71	6572894.1	1	-30.725	5.6899199	24	18	10	4	0	6	0	0	0	0	0.114753	0.0856579	0.0766664
630607.85	6571143.7	1	-42.201	20.6968	16	11	0	-5	15	0	0	0	0	0.131972	0.0831922	0.0868334	0.096781
629310.2	6570006.8	1	-57.081	1.0169801	0	-1	0	0	50.2892	32.311001	24.1868	25.806999	26.8328	0.0035237	0.0010213	0.0006329	0.000235